Global Positioning System Data Acquisition and Processing

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Purpose

This document was developed to provide guidance and standard operating procedures for Global Positioning System (GPS) use within the North Coast and Cascades Network (NCCN) of the National Park Service (NPS) Inventory and Monitoring (I&M) Program. The primary goals are to comply with NPS GPS and GIS data accuracy standards and to improve the quality and usefulness of GPS data created for I&M resource management projects.

Detailed specifications and instructions about different GPS units and their associated software, data processing, and data formatting standards for I&M spatial data are included in this document. Adherence to these guidelines will promote GPS and GIS data quality and spatial accuracy, and facilitate better documentation of GPS-derived spatial data.

Scope and Applicability

These guidelines should be used by NCCN GIS Specialists, Project Leads, Data Managers, and NPS cooperators and contractors who will create and process GPS-derived spatial data. Spatial data that will be stored in one of the NCCN or individual park digital databases or submitted to any of the national NPS data repositories (NR-GIS Metadata and Data Store, Biodiversity Data Store, etc.) should use these guidelines. Those creating or submitting GPS derived spatial data to NCCN are encouraged to work with NCCN GIS Specialists during all stages of data design, creation, and spatial data production.

Definitions and Acronyms

2D	GPS positions collected with three satellites.
3D	GPS positions collected with a minimum of four satellites.
Attribute table	A tabular file containing rows and columns. Attribute tables in GIS are normally associated with a class of geographic features (points, lines or polygons). Each row represents a geographic feature. Each column represents one attribute of a geographic feature.
Base station	GPS receiver at a surveyed location that collects satellite data for purposes of correcting GPS rover files.
Coverage	The ESRI ArcInfo® spatial vector data model. Geographic features are symbolized by points, lines, polygons, routes, or regions. A coverage contains both the spatial (location) and attribute (descriptive) data for geographic features.
Database	A collection of data organized according to a conceptual structure describing data characteristics and relationships among corresponding entities. For example, a GIS database includes data about the position and characteristics of spatial features.
Data dictionary	Documentation of specifications for each field in a data set, describing field attributes such as data type, field size, domain, range limits, and validation rules.
Datum	Geographic coordinate system. Reference frame for location measures derived from a mathematical representation of the earth's shape (an ellipsoid).
ESRI®	Environmental Systems Research Institute, Inc. of Redlands, CA. Makers of ArcView®, Arc/Info® and ArcGIS® GIS software.

Differential correction	Process of improving GPS data accuracy by using base station measurements to correct errors in GPS rover files.
Foreign key	The column or combination of columns whose values match the primary key or unique key in the same or another table. Also called the referencing or link key.
Geodatabase	The ESRI name for a 'geographic database'. The geodatabase model is an ArcGIS (version 8.x or higher) data storage format. A geodatabase represents geographic features and attributes as objects and is maintained within a relational database management system (e.g., Microsoft Access® or SQL Server® 2000).
GIS	Geographic Information Systems. A computer system for storing, analyzing, and displaying spatial data.
GPS	Global Positioning System. A radio-based navigation and mapping system that consists of a constellation of approximately 24 satellites that transmit radio signals to receivers that calculate coordinate position.
HDOP	Horizontal dilution of precision. Measure of satellite geometry for 3D positioning.
Horizontal error	Measure of the horizontal error in a GPS position. Lower value indicates higher position accuracy.
I&M	Inventory & Monitoring Program of the National Park Service.
Multipath error	GPS measurement errors caused by satellite signal interference (from objects like trees, houses, etc).
NAD 83	North American Datum of 1983. Horizontal datum referencing GRS-80 ellipsoid.
NCCN	North Coast and Cascades Network of the National Park Service. http://www1.nature.nps.gov/im/units/nccn
NPS	National Park Service.
PDOP	Position dilution of precision. Measure of satellite geometry for 3D positioning. Includes HDOP and VDOP. Lower value indicates higher position accuracy.
Post-processing	Applying differential corrections to GPS rover file(s) using base station data.
Primary key	A field or set of fields that uniquely identifies each record in a table. Primary keys may not contain null values.
Receiver	GPS unit that receives satellite signals.
Rover file	GPS data stored in a file within GPS receiver.
Shapefile	An ESRI GIS format that stores non-topological geometry and attribute information for the spatial features in a data set. The geometry for a feature is stored as a shape comprised of a set of vector coordinates. Shapefiles can support point, line, and area features.
SNR	Signal to noise ratio. An indicator of satellite signal strength.
Vector	Data format that supports points, lines, or polygons. Spatial features with locations defined by x, y coordinates (points) or a series of x, y coordinates connected by linear segments (lines, polygons).
Waypoint	An X, Y coordinate entered into a GPS receiver to represent a location of interest.
WGS 84	World Geodetic System of 1984. Mathematical ellipsoid used by GPS.

Overview

These guidelines address the process and requirements of GPS data creation for the NCCN. A discussion about differential correction highlights the need for collecting the most accurate location data possible. A

work flow is presented for projects that will use GPS. Standard operating procedures for specific GPS units and software used by the NCCN are located in the appendices.

The outlined work flow addresses GPS needs assessment, GPS data design, GPS data collection, processing and quality assessment, GPS data integration with project spatial and non-spatial databases, and GPS data documentation (Figure 1).

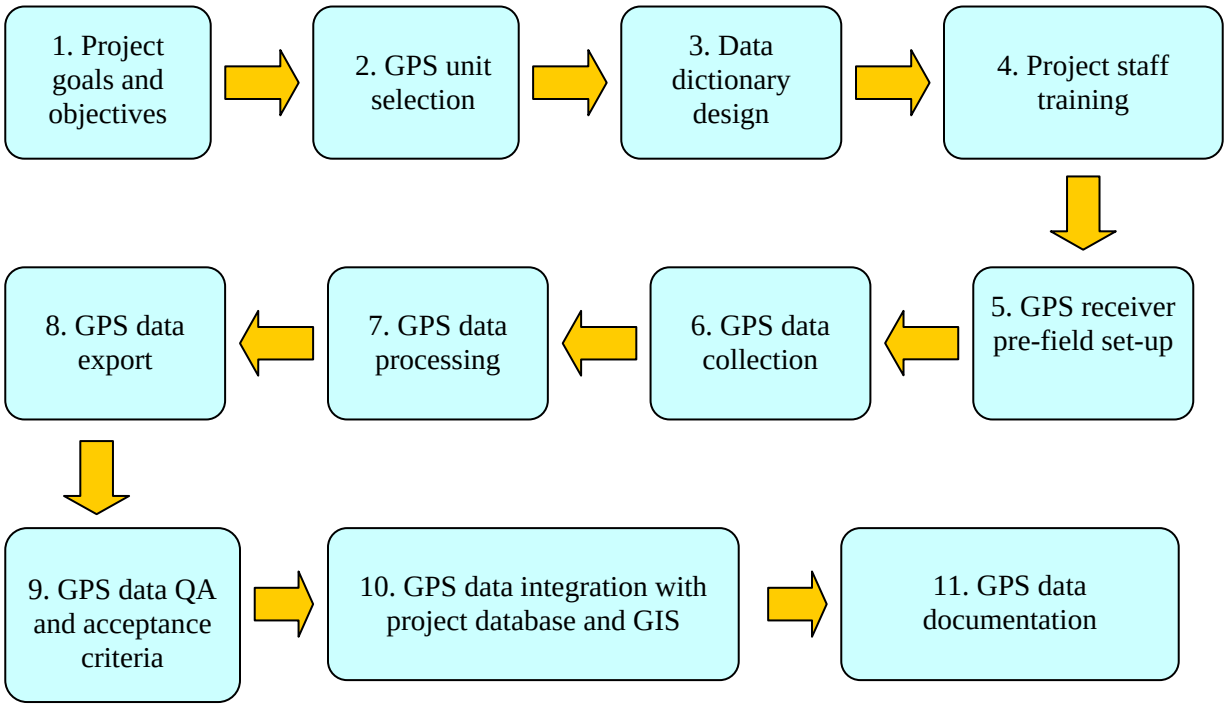

Figure 1. Work flow diagram for GPS data needs, design, collection, and processing.

General Information

NCCN GPS Equipment and Software

The NCCN uses GPS units that have differentially correction capabilities. The GPS units most used are: Trimble GeoExplorer II, Trimble GeoExplorer 3, Trimble GeoXT, Trimble GeoXM, and Thales MobileMapper with the differential correction utility. Associated GPS software programs are run on Microsoft Windows operating systems.

Note: The NCCN uses Trimble and Thales products, but does not endorse these products.

Reasons to Use Differential Correction in the NCCN

Much of the NCCN is characterized by rugged, mountainous, forested terrain. The physical nature of these areas makes GPS data collection highly challenging. Satellite signals are often blocked or bounced around by terrain and trees. Field experience and GPS unit testing in the NCCN has shown that differentially corrected GPS data have better accuracy (smaller vertical and horizontal errors) than uncorrected data from recreational GPS receivers, especially in forested areas (Appendix 1).

Differentially correctable GPS data are stored in files within GPS units. Some GPS receivers that collect differentially correctable data allow users to configure data collection settings. Conversely, recreational GPS receivers do not store data in files, waypoint positions are not differentially correctable, and data collection settings cannot be configured by users. Recreational GPS units have widely ranging location errors with less error in open areas and more error in forested areas (Appendix 1).

Each project will have its own data accuracy needs, depending on goals and objectives. If GPS is needed only for general navigation in the field, then a receiver without differential correction capabilities may suffice. If navigation or mapping with specific accuracy is needed, then GPS receivers that record differentially correctable data provide better accuracy and more fully documented data. These processed and documented data can be stored in NCCN standard database tables and used for accuracy evaluation, coordinate documentation, and mapping.

Future project data use and integration should also be considered when selecting a GPS receiver. Data collected for one project may also be highly useful to other projects. It is desirable to collect the highest quality coordinate data possible for most NCCN projects.

Procedures

1. Project Goals and Objectives

Project Lead or Principle Investigator, GIS Specialist, and Data Manager should cooperatively review a project proposal to determine whether or not GPS data collection will be needed to meet project goals and objectives. These goals and objectives should be clearly outlined and data collection protocols should be stated so that GPS needs can be matched to project needs. Project objectives will determine spatial mapping accuracy needs and data collection methods will determine what types of features will be mapped (points, lines, or polygons) (see GIS Development Guidelines (NCCN 2006b)). Feature type will in turn determine how the data will be incorporated into one or more NCCN spatial and/or non-spatial databases (see Section 10 of this document and NCCN Database Standards (NCCN 2006a, in development)).

Quality assurance (QA) procedures and data acceptance criteria for GPS data should be discussed and outlined. Spatial data collected with GPS can be imported into non-spatial project databases and analyzed with QA queries to check for attribute or relationship errors. GIS can be useful for finding labeling and positional errors and for conducting spatial analysis (see GIS Development Guidelines (NCCN 2006b)).

2. GPS Unit Selection

Parks within the NCCN have varying numbers of GPS units and models. Some GPS receivers are purchased for specific projects and are reserved, while others are available for long-term or short-term check-out.

If GPS units are not available, a Project Lead may choose to purchase one or more units. GPS receivers with differential correction capability cost significantly more than recreational receivers, which generally do not log differentially-correctable data. For example, a Garmin eTrex costs approximately $100, while a Trimble GeoXT unit costs about $6,000, a GeoXM unit costs about $2,300, and a Thales MobileMapper unit costs approximately $1,700.

Choice of GPS receiver type and configuration will largely depend on project data collection methods. GPS unit memory will need to be sufficient to store the amount of data field crews anticipate collecting before they are able to come back to a computer and download data. Battery types, weights, and

longevity will also need to be considered. External antennas can be used if data collection will occur in areas where satellite signal reception is challenging. Some GPS receiver models can display background maps which can aid field crews in navigation. In this case, project staff will need to develop and transfer these background maps to the GPS unit before going out in the field (see SOPs for specific units for instructions on background map development and data transfer).

Mission planning charts are available in Trimble Pathfinder Office and Thales MobileMapper Office software packages. Field crews may need to tailor their field work around the times of day when the greatest number of satellites is available and when satellite geometries are best. See Appendices 6 and 9 for instructions about mission planning.

Computer availability (laptop or workstation) must be assessed. GPS units can store varying amounts of data depending on manufacturer and model, but it is safest to transfer GPS data as often as possible into computer or network folders that have a regular backup schedule.

3. GPS Data Dictionary Creation

Data collection is enabled through the use of data dictionaries ("feature libraries" in Thales terminology). Using a data dictionary, even if only one attribute is entered for each mapped location, makes data entry in the field and post-processing more efficient. Data dictionary use results in fewer errors when transferring data to external databases because it eliminates additional manual data entry. However, GPS data dictionaries are not intended to replace databases, hard copy datasheets, or field computers.

A GIS Specialist should use a project's data dictionary to create a GPS data dictionary (see GIS Development Guidelines (NCCN 2006b). At a minimum, items that uniquely identify a coordinate location (i.e., plot names or numbers that can potentially become a database primary key), should be added to the project GPS data dictionary. Data dictionary item names are truncated to eight characters by GPS data dictionary software. GPS data dictionary names should conform to GIS naming conventions if possible, or be easily related to database items (see NCCN Database Standards (in development) and GIS Naming Conventions (NCCN 2005)). The Project Lead or Principal Investigator, with the help of GIS Specialist or Data Manager, should determine which attributes should be recorded via data dictionary in the field for each GPS feature.

Data dictionaries are created in GPS software packages on computers and are transferred to individual GPS receivers via USB or serial connections (see SOPs). Multiple data dictionaries can be loaded into each GPS receiver. The desired data dictionary is selected during the receiver configuration process or by users in the field prior to opening a data file. Consult GPS processing software help files for assistance with data dictionary creation.

4. GPS Training for Project Staff

Project staff training is essential to the proper and efficient use of GPS units. Field crew training at the beginning of a field season will produce higher quality data during the field season. Project Leads or Field Crew Leaders should schedule sufficient time, typically one day, for GPS receiver and software training before full-scale data collection proceeds. Relatively large field crews or more complex data collection needs may require more training time.

GPS data handling responsibilities should be agreed upon before GPS training or data collection begins. Access to internet and post-processing software, as well as proficiency with GPS and GIS will determine who will post-process, export and check the accuracy of collected data. Field crews might require additional training to be able to do the work themselves. Standard operating procedures have been

developed to provide field crews with specific instructions on GPS pre-trip planning, data collection, and post-processing:

- Appendix 1. Reasons to use differential correction in the NCCN
- Appendix 2. Trimble GeoXM and GeoXT receiver preparation and data collection
- Appendix 3. Trimble GeoXM and GeoXT data processing
- Appendix 4. Trimble GeoExplorer II operating instructions
- Appendix 5. Trimble GeoExplorer 3 operating instructions
- Appendix 6. Trimble GeoExplorer II and 3 receiver data processing and export
- Appendix 7. Trimble mission planning chart creation
- Appendix 8. Thales MobileMapper operating instructions
- Appendix 9. Thales MobileMapper data processing and export
- Appendix 10. Thales MobileMapper mission planning chart creation
- Appendix 11. Thales MobileMapper background map creation
- Appendix 12. Aerial GPS data collection using Trimble GeoExplorer 3

5. GPS Receiver Pre-field Set-up

NCCN Projection and Datum

The latitude and longitude coordinate system using the World Geodetic System 1984 (WGS84) datum is the native coordinate system broadcast by GPS satellites. However, GPS units and their associated software can be configured to *display* data in any coordinate system and datum (the actual positions are still collected in WGS84). The current NCCN coordinate system standard is Universal Transverse Mercator (UTM) zone 10. Measure units for the UTM projection system are meters. The current NPS standard is North American Datum (NAD) 1983 and the current NPS standard ellipsoid is the Geodetic Reference System (GRS) 80.

GPS Unit Configuration

Once GPS equipment and data collection needs have been established, GPS units must be properly configured. Consult with a NCCN GIS Specialist or Data Manager to discuss configurations that will meet project objectives and to have configurations entered into GPS units. It is easy to overlook a configuration setting that can greatly impact data collection, processing and quality. A configuration file can be saved as a Trimble file (.ccf) or as a TerraSync file (see Trimble's Pathfinder Office Help).

The GIS Specialist is responsible for properly configuring each GPS unit or for providing configuration training to field crews. GPS unit configuration involves specifying options for elevation, PDOP or HDOP, and SNR masks, and for position averaging, feature logging intervals, and 2D vs. 3D position logging. It also includes selecting the display coordinate system and datum, time display (12 hour vs. 24 hour clock) and offset from UTC time. If applicable, it may also include loading data dictionaries and background layers.

Background Map File Preparation

Background maps can be used for reference during fieldwork. For example, a background map can show roads, trails, park boundaries, and target points or polygons where field crews will place plots. Trimble and Thales GPS receivers can display vector data (points, lines, polygons) in a background map. Shapefiles can be imported into either Pathfinder Office and saved as a Pathfinder Office import file (.imp) or into MobileMapper Office and saved as a map file (.mmp). Import files can be transferred from

a computer to GPS receiver(s). See Appendix 11 for creating MobileMapper background maps. Contact NCCN GIS staff for Trimble background map creation. See Appendix 2 for Trimble XM and XT background map file transfer instructions.

Planning Charts

Some GPS models and associated software have mission planning utilities which are helpful for planning field work. These utilities can produce charts displaying satellite information such as the number of satellites available, PDOP, HDOP, and satellite health at different times of the day for selected areas. Planning charts are useful in determining the best times of day for satellite reception and can be helpful references while in the field. Trimble Pathfinder Office (Appendix 7) and Thales MobileMapper (Appendix 10) have mission planning capabilities.

Directory structure for storing GPS files

Some organizational set-up is needed before GPS data collection begins. First, computer or network directory structures for GPS data should be created. Each project or park may have a different directory structure, and some software programs provide a default directory structure. For example, Trimble Pathfinder Office uses Project_name as the parent folder and Backup, Base, and Export as the subfolders in which the backup rover files, base station files, and exported GIS layers, respectively, are stored. An example of a directory structure for a project's GPS data is provided below:

N:\Project_code\GPSData\
- Base
- Export
- Processed
- Raw

In this example, "N:\" is a network drive (or a hard drive that has a regular backup schedule), "Project_code" is the NCCN-assigned project code, and "GPSData" contains the GPS-related subfolders. These subfolders are "Base" which stores base station files used for differential correction, "Export" which stores GPS data exported to GIS or database formats, "Processed" which stores GPS files that have been post-processed, and "Raw" which stores the original, un-processed GPS rover files. Each I&M protocol will have its own suggested, project-specific directory structure.

GPS File Name Standards

GPS file names should be standardized before field data collection begins. This prevents duplicate file names which can lead to data being overwritten, and it facilitates efficient data file processing, storage, and future reference. At Olympic (OLYM) and North Cascades (NOCA) National Parks, each GPS unit is assigned a different letter of the alphabet for use in file names so that duplicate file name issues are avoided and so that files can be traced back to their source receiver.

Trimble GPS units use a default file name of a letter prefix (the default is "R") followed by the month (MM), day (DD), hour (HH), and an alphabetical letter. The hour displays Universal Coordinated Time (UTC).

Thales MobileMapper receivers use a default file name of "Job1" followed by a sequential number. Changing default file names to the GPS unit's assigned letter followed by a two digit year (YY), month (MM), and day (DD) has proven to be a useful way to manage MobileMapper GPS files at OLYM.

6. GPS Data Collection

General Practices for GPS Data Collection

Regardless of GPS receiver type, certain data collection standards must be followed. Most of the quality control measures below can be established by the user and should be followed whenever possible to produce the most accurate data possible.

- Satellite availability and satellite geometry (PDOP):
  GPS users can increase mapping accuracy by using planning charts and targeting their data collection to the times of day when satellite availability and geometry are best. Such timing does not always work in the field, however. PDOP option in the GPS receiver, if available, should be set to no higher than 8 (PDOP of 6 is preferred). The user should not increase the allowable PDOP value to higher than 8 unless collecting a position overrides accuracy concerns.
- Length of time GPS data file is open
  Positional accuracy will be better the longer a file is open and the more GPS positions are collected and averaged (Figure 4 in Appendix 1). Trimble recommends a minimum of 60 positions for each point or vertex feature to attain a high degree of accuracy.
- Mulitpath error, or signal interference
  While mostly beyond a user's control, some adjustments can be made to minimize multipath error. These include positioning the GPS in the most unobstructed view of the sky as possible, using offsets from better satellite reception areas to the target location, and using an external antenna.
- Signal to Noise Ratio (SNR)
  This is out of a user's control, although Trimble units allow a minimum ratio value to be set in the configuration such that positions with SNR below that value are not logged. A value of 4 is recommended for SNR values in Trimble units.

GPS file names should be recorded on hardcopy datasheets or in field computers. GPS field coordinates (coordinates shown on a GPS receiver while a GPS is receiving satellite signals) and datum should also be recorded on hardcopy datasheets. In the event a GPS file is lost or corrupted, the coordinates recorded in the field from the GPS unit display window will become the best measure of location. Be aware that these coordinates cannot be differentially-corrected and are in the coordinate system and datum that were chosen for the unit's display.

7. GPS Data Processing

Processing differentially correctable GPS rover files requires a computer, a data transfer cable, GPS software, and internet access. GPS receivers typically come with manufacturer-specific software and data transfer cables. Each software package operates differently, but the basic process is the same.

It is extremely important that whenever field crews return from the field, GPS files are transferred from GPS receivers to computers or network folders that are routinely backed-up. Files should be transferred to an appropriately-named folder (such as "Raw" or "Backup").

Files can be selected one by one or in batches for differential correction with base station files. Base stations and associated files necessary to correct rover GPS files can be selected via the GPS software interface with the internet or through ftp sites if provided by the base station of interest.

The GPS software uses the base station files to calculate rover file corrections. In order for corrections to be calculated, the base station needs to have collected data from the same satellites and times that the roving GPS receiver collected data. Base stations within 500 km (310 Miles) of where GPS data were collected should be used for increased GPS data accuracy and to avoid base station and receiver file satellite tracking mismatches.

Not all files will differentially correct 100%. This is not unusual for GPS data collected in NCCN parks. Uncorrected data within a file typically results from missing base file measurements (a base station and a GPS field receiver will access different satellites) or a corrupted GPS file. If correction percentages are relatively low, processing the file(s) using a different base station may result in higher correction percentage.

A GPS file can be exported to GIS or database format with an attribute field indicating if the file was corrected or not (Trimble Pathfinder Office and Thales MobileMapper Office), or it can be filtered during export so that uncorrected data are excluded (Trimble Pathfinder Office).

Appendices 2, 5, and 8 contain specific directions for differential correction of Trimble and Thales GPS files.

8. GPS Data Export

The NCCN primarily uses ESRI GIS products on Microsoft Windows operating systems. The ESRI products most frequently used by the NCCN are ArcInfo, ArcView, and ArcGIS (ArcMap, ArcTools, ArcCatalog).

Processed GPS files can be exported to a variety of formats. Trimble Pathfinder Office Export allows users to select many types of output, among them ArcInfo generate files, ArcView shapefiles, or Access database files. Thales MobileMapper Office exports ArcView shapefiles and associated comma delimited text (.csv) files. MobileMapper Office exports a standard set of attributes. Pathfinder Office exports user selected attributes.

See Appendices 2 and 5 for Pathfinder Office data export directions and a list of attributes to export so that position quality can be evaluated. See Appendix 9 for MobileMapper data export directions.

9. GPS Data Quality Assurance and Acceptance Criteria

Data dictionary use will promote higher quality data collection in the field. Data entry errors can be minimized by using the properties available in GPS data dictionary creation software. Similar to Access database design, items can be assigned specific domains and controls. For example, items can be assigned as mandatory data entry fields, pick lists can be created, and numeric fields can be assigned a data entry range.

After post-processing and exporting procedures, GPS data should go through quality assurance (QA) procedures and meet project-specific data acceptance criteria. Each project will differ, but some QA measures can be taken as GPS data are being processed. More specific procedures can occur in database queries and filters.

Generating GIS layers from GPS data can be useful for visual checks against maps of known accuracy, checking for labeling errors, and for spatial analyses to answer questions such as “how near was the field crew to the target location?”

See NCCN Quality Assurance Guidelines (NCCN 2006c, in development) and NCCN GIS Development Guidelines (NCCN 2006b) for further QA and acceptance criteria guidance.

10. GPS Data Integration with Project Database and GIS

GPS data should not be standalone data. Ideally, the data will be imported into one or more databases and/or GIS. The NCCN has developed two standard database tables to hold spatial and GPS data. These tables are part of the NCCN Database Standards (NCCN 2006a, in development). The tables are:

- tbl_Coordinates
  - stores field, GPS, and target coordinate data along with GPS file name, general comments, and offsets recorded in the field but not entered into GPS files
- tbl_GPS_Info
  - stores exported GPS feature attributes and processing notes

These tables are intended to document locations (GPS or otherwise derived), method of assigning coordinates for each, and the quality of those coordinates. These tables are also useful for creating queries through which QA procedures can be conducted.

The database tables have been designed to allow coordinate data, including GPS-derived data, to be exported into formats for GIS layer creation. See NCCN GIS Development Guidelines (NCCN 2006b) for further detail about GIS spatial data creation. See NCCN Spatial Data Integration (NCCN 2006d, in development) for details about different methods of linking GIS layers with external tabular data. See NCCN GIS Product Specifications (NCCN 2005b) for details about final spatial product specifications.

11. GPS Data Documentation

GPS is typically used as a means to create location data in a GIS or in a project database. Project databases and GIS layers are documented with metadata records. A combination of these metadata records and a project proposal or a protocol document should contain the following GPS information:

- Type(s) of GPS receiver(s) used
- GPS receiver firmware version
- GPS software version
- General GPS data collection methods
- General GPS data processing methods
- QA procedures
- Identify the final destination of GPS data as either a GIS layer and/or project database

Responsibilities

- Project Leads (NPS) or Principal Investigators (non-NPS) who use GPS to create spatial data are responsible for consulting with NCCN GIS Specialists during GPS data design, collection, processing, export, and integration stages.
- NCCN GIS Specialists are responsible for providing GPS technical training and support to Project Leads, Principal Investigators and field crews, as well as information about GPS and GIS availability and capabilities within the NCCN to all parties requesting such information.
- Project Leads or Principal Investigators and GIS Specialists should agree on GPS data handling responsibilities before data collection begins.
- NCCN GIS Specialists will verify that submitted GPS data adhere to formats used in the NCCN.
- Project Leads and GIS Specialists will coordinate metadata record creation.

Reference Documents

Guidance

Boetsch, J.R., B. Christoe, and R.E. Holmes. 2005. Data management plan for the North Coast and Cascades Network Inventory and Monitoring Program. USDI National Park Service. Port Angeles, WA. 89 pp. Available at: http://www1.nature.nps.gov/im/units/nccn/dm_docs/NCCN_DMP_Sep2005.pdf

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North Coast and Cascades Network – National Park Service. 2006d. NCCN Spatial Data Integration. USDI National Park Service. Available at: http://www1.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm (in development).

Other Citations and References

For general GPS information and NPS applications:
National Park Service Global Positioning Systems website, available at: http://www.nps.gov/gis/gps/

For GPS information from the NPS Alaska Regional Office:
http://inpakroms03web/rgr/gps/tips.htm

For Trimble products specifications, support, and tutorials:
Trimble website, available at: http://www.trimble.com/

For Thales product specifications and support:
Thales Navigation, Inc. website, available at: http://products.thalesnavigation.com/en/

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Olympic National Park 600 East Park Avenue Port Angeles, WA 98362-6757	John R. Boetsch, Data Manager 360-565-3064 john_boetsch@nps.gov Roger Hoffman, GIS Coordinator 360-565-3062 roger_hoffman@nps.gov Katherine Beirne, GIS Specialist 360-565-3063 katherine_beirne@nps.gov
Ebey's Landing National Historical Reserve	Please refer to contacts for North Cascades NP
Fort Vancouver National Historic Site	Please refer to contacts for Mount Rainier NP
Lewis and Clark National Historical Park	Please refer to contacts for Mount Rainier NP
San Juan Island National Historical Park	Please refer to contacts for North Cascades NP

Revision History

Revision Date	Description of Change	Author	Effective Date
Mmm dd, yyyy		Full name	Mmm dd, yyyy

Appendix 1. Reasons to Use Differential Correction in the NCCN

Much of the NCCN is characterized by rugged, mountainous, forested terrain. The physical nature of these areas makes GPS data collection highly challenging. Satellite signals are often blocked or bounced around by terrain and trees. Field experience and GPS unit testing in the NCCN has shown that differentially corrected GPS data have better accuracy than uncorrected data, especially in forested areas.

For example, differences between corrected and uncorrected Trimble GeoXT data from a best-case terrain scenario at San Juan Island National Historical Park (SAJH) were as much as 0.5-5.0 meters (Figure 2). In this project, data were collected in an open site where satellites were not obscured by canopy cover and satellite signal was not degraded by multipath. Worse spatial accuracy should be expected in mountainous or forested terrain or with use of recreational type GPS receivers, such as Garmin units.

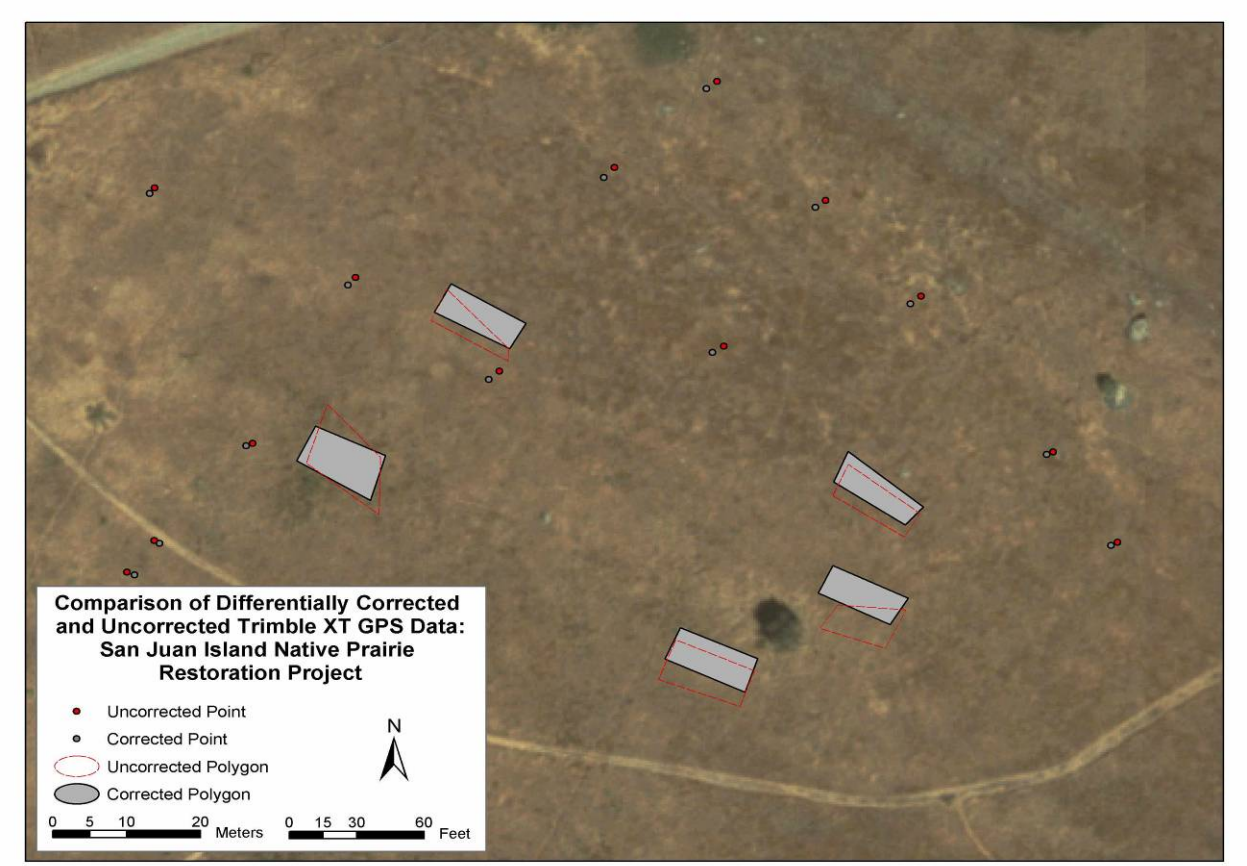


Figure 2. Comparison of differentially corrected and uncorrected Trimble GeoXT GPS receiver data in an open prairie at San Juan Island National Historical Park, 2005.

Recreational GPS receivers were tested by USFS personnel at two locations in Oregon (Mancebo and Chamberlain, 2000a). Units were tested in an open sky control station, Estacada, and under forest canopy on the Clackamas course. The authors noted a significant decrease in accuracy in forested areas (Figure 3).

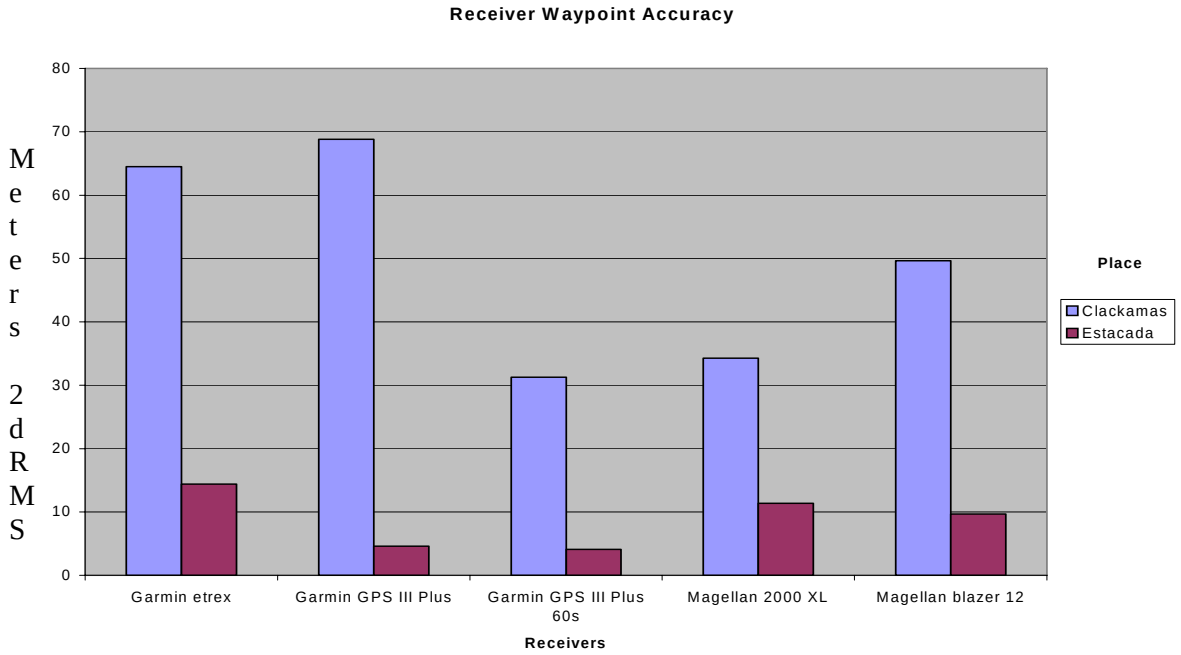


Figure 3. Recreational GPS receiver waypoint accuracy under forest canopy at the Clackamas test site and at the open sky control station Estacada, Oregon (Mancebo and Chamberlain, 2000a).

The accuracy of collected data did not meet the National Map Accuracy Standards of 12.2 meters, at a 90% confidence interval, on a 1:24,000 scale quadrangle map. The study reported an accuracy of 14.8 meters at a 95% confidence interval (Manceba and Chamberlain 2000a).

Recreational GPS receivers do not store data in files, waypoint positions are not differentially correctable, and data collection settings such as PDOP and SNR masks cannot be configured by users. Recreational GPS units have widely ranging location errors with less error in open areas and more error in forested areas.

In another study, Mancebo and Chamberlain (2000b) tested Trimble's GeoExplorer 3 GPS receiver in the open Estacada site and in the forested Clackamas site (Figure 4). Differential correction reduced error, especially for data collected during a relatively short period of time (< 2 minutes).

Differentially correctable data provide better accuracy and more fully documented data. Differentially-corrected GPS data can be attributed with information about positional accuracy and time of data collection (e.g. horizontal error, vertical error, standard deviation of averaged point locations, PDOP, HDOP date, and time). These data can be stored in NCCN standard database tables and used for accuracy evaluation, coordinate documentation, and mapping.

Each project will have its own data accuracy needs, depending on goals and objectives. If GPS is needed only for general navigation in the field, then a receiver without differential correction capabilities may suffice. If navigation or mapping with specific accuracy is needed, then GPS receivers that log differentially correctable data provide better accuracy and more fully documented data. These data can be stored in NCCN standard database tables and used for accuracy evaluation, coordinate documentation, and mapping.

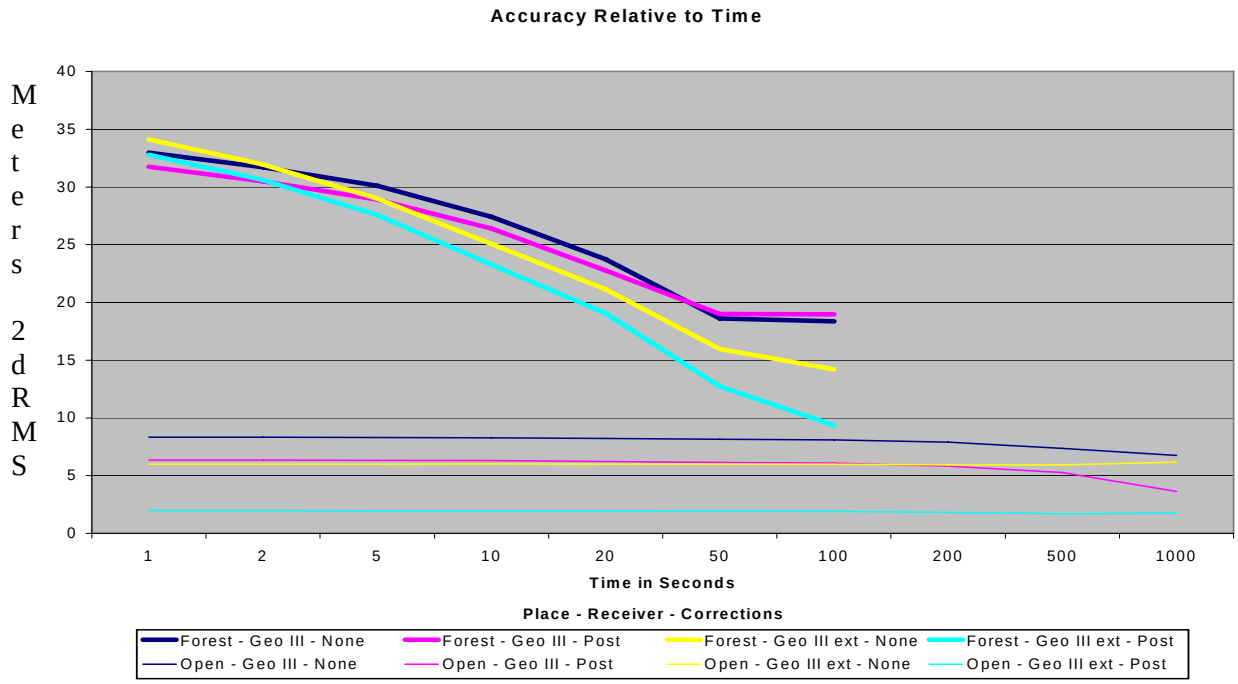


Figure 4. Comparison of differentially corrected and uncorrected data collected with a Trimble GeoExplorer 3 GPS receiver in open and forested areas (Mancebo and Chamberlain, 2000b).

Future project data use and integration should also be considered when selecting a GPS receiver. Data collected for one project may also be highly useful to other projects. For example, the NCCN vegetation mapping project researchers have been compiling data from other projects that recorded vegetation measurements. Of these data sets, only those that had accurately mapped locations were appropriate for the vegetation mapping project. It is desirable to collect the highest quality coordinate data possible for most NCCN projects.

Appendix 2. Instructions for Trimble GeoXM and GeoXT GPS Units with Trimble Pathfinder Office and TerraSync Software: Pre-field Preparation and Data Collection

Overview

Trimble GeoXM and GeoXT GPS units are handheld receivers and dataloggers with internal antennas and power supplies. *Please be gentle with these units!* In the office, these units should rest in a 'support module' which plugs into a power source and connects to a computer via a USB port. The support module acts as a battery charger and allows data transfer between the computer and the receiver. The supporting software programs are TerraSync and Pathfinder Office. TerraSync is loaded directly onto the GeoXM/XT units and is used for GPS unit configuration and data collection. Pathfinder Office is loaded onto desktop computers and is used to transfer data files to and from the GPS receiver, conduct trip-planning, create background layers, create and edit Data Dictionaries, view and differentially correct GPS data, and export GPS data to other formats, such as GIS layers. The following instructions are based on using Pathfinder Office v. 3.00 and TerraSync v. 2.41.

Pre-field Preparation

1. Connect GPS receiver to the desktop computer for GPS trip-planning, loading background files and Data Dictionaries, and data transfer to and from the GPS unit.
    A. Connect GPS unit to computer using support module and USB cable, if USB is available, or with serial clip attached directly to the unit.
        i. If unit is off, it will automatically turn on when placed in support module.
        ii. If the unit is already on, it is recommended to put it in "suspend mode" before placing in the support module (depressing the power button once briefly when the unit is on puts it in suspend mode; the screen will go black). Again, it will automatically turn on once connected.
    B. Microsoft ActiveSync must be installed on the computer (should be version 3.7.1, build 3244, or newer) and should automatically start once the GPS unit is connected. If it does not, start it manually by double-clicking icon on desktop or through Start/Programs/ActiveSync.
        i. In *New Partnership* dialog box, select *No*. Unit will be set up as a 'guest' on the computer.
        ii. Click *Next* button. Connection to the computer is now established.
    C. Transferring files between a desktop computer and the GeoXM/XT is accomplished using the Data Transfer utility in Pathfinder Office (see Step 6, "Transfer Data Dictionary and background files to the receiver," for details).
        i. Most file types undergo a conversion process during data transfer in Pathfinder Office to be compatible with the TerraSync software in the GPS unit. For this reason, it is recommended to use this Data Transfer utility rather than copying and pasting through Windows Explorer.
2. Create a new "project" in Pathfinder Office for managing all of the GPS files related to a specific resource management project: GPS rover files, base station files for differential correction, and GIS files (shapefiles exported from GPS rover files).
    A. Start Pathfinder Office.
    B. ***Select Project* window** opens. Click *New*.
    C. In ***Project Folders* window**, assign a project name in Project Name field. Click in Project Folder field; location automatically updates with specified name (usually this will be C:\Pfdata\YourProjectName). Click *OK* (the Backup, Export, and Base File fields should default to subfolders in the newly created project folder).

D. **Important!** Specify display coordinate system for all files in the project by selecting *Coordinate System* under the *Options* menu. If GPS data will be displayed with background GIS data in Pathfinder Office, the coordinate system must be set to that of the GIS data.
   i. For most NCCN parks, the following should be selected: UTM for System, 10 North for Zone, NAD 1983 (Conus) for Datum, Mean Sea Level (MSL) for Altitude Measured From, and Meters for both Coordinate and Altitude Units.
   ii. For Geoid Model, select the 'Other' radio button, then select GEOID99 (Conus) from the dropdown list (or whichever 'GEOIDxx (Conus)' is the most current, where xx denotes the year).
      a. If elevation GPS data is going to be collected, it may be advised to download the latest geoid model from the Trimble website at: http://www.trimble.com/geoid_ts.asp?Nav=Collection-22910. For NCCN, select either GEOID03 (Region 1) or GEOID03 (Conus).
      b. This geoid model will facilitate the greatest vertical accuracy when exporting the GPS data to GIS.

E. Distance and area units can also be specified from the *Options* menu.

3. Determine the best days and times to collect data in the field using either the planning utility in Pathfinder Office.
   A. First, obtain a current GPS almanac by either of the following two methods:
      i. Download the almanac file from the Trimble website: http://www.trimble.com/gpsdataresources.html, click on 'GPS almanac in SSF file format'. File name will be 'current.ssf'. Save to C:\Program Files\Common Files\Trimble\Almanacs\.
      ii. With GeoXM/XT GPS receiver turned on, go outside and wait for an almanac file to download from a satellite (to activate TerraSync and connect to GPS, refer to 'Field Data Collection' below).
         a. This can be monitored in the ***Status* window** of TerraSync and usually takes about 5 minutes. "Almanac received" will display at the top of the screen when done.
         b. Transfer the almanac file from the receiver to the computer via the Data Transfer utility in Pathfinder Office (see Step 6). Pathfinder should automatically copy the file to same directory indicated above and name it 'almanac.ssf.'
   B. In Pathfinder Office, Select *Quick Plan* under the *Utilities* menu and select the anticipated date of field data collection.
      i. Specify the location of data collection in one of three ways from the *Edit Point* window:
         a. Click the *World Map* button, click on area of interest on the map and then the Magnify button to zoom in. Repeat zoom until a specific city closest to desired area can be selected, then click *OK*, then *OK* again.
         b. Click the *Cities* button, then click the Local button and select the city closest to area of interest. Click *OK*, then *OK* again.
         c. Click the *Keyboard* button and enter the name and latitude/longitude (in degrees, minutes, seconds) of area of interest. Select *Estimated Coordinates* in the Position Quality option. Click *OK*, then *OK* again. Centroids for the NCCN parks are provided in latitude (north) and longitude (west) below (Table 1).

Park	Degrees	Minutes	Seconds
FOVA	45	37	22.7638
	122	39	46.7793
SAJH	48	59	24.8918
	123	2	51.7432
LEWI	46	20	11.0227
	123	52	46.4688
NOCA	48	54	4.9909
	121	8	27.3215
EBLA	48	8	0.0000
	122	41	20.4317
MORA	46	36	14.3073
	121	42	20.6288
OLYM, main	47	56	0.0000
	123	37	9.5929
OLYM, coast	47	41	19.8614
	124	35	27.7040

Table 1. NCCN Park Centroids in Latitude and Longitude.

ii. The *Status* window will appear with Point name, coordinates, and date. Almanac file information will be blank.

iii. From the *Graph* menu, select the desired information to display (for example: Number of Satellites, PDOP, HDOP). The graph will display the number of satellites, satellite trajectories, PDOP or HDOP values, or whatever information was specified, for the day and location selected.

a. The *Status* window will update with information from the most current Almanac file in the directory indicated above (date of file, satellites considered).

b. To use a different almanac file, specify this by selecting *Almanac* from the *Options* menu, selecting either .SSF or .EPH file type, and browsing to where file is located.

C. A snapshot of satellite availability, trajectories, and PDOP/HDOP values for the current day can be viewed directly on the GeoXM/XT in the field. This does not allow for advance planning, however. Note: A current almanac must be downloaded from a satellite to the GPS receiver first; almanac files cannot be transferred from a desktop computer to the GPS unit.

i. From the ***Status* window**, select *Plan* from the dropdown menu (below main dropdown list in upper left).

ii. An animated skyplot and DOP graph can be viewed for the current position for any time over the next 12 hours.

4. Create Data Dictionary either in Pathfinder Office (much faster and the preferred approach) or on the GeoXM/XT unit. Data Dictionaries are files that define lists of features and associated attributes related to data being collected for a specific project and are loaded onto the GPS units. They reduce error and save time during data entry by eliminating the need to enter data in the office. However, a field form should *also* be filled out in the field in case electronic GPS data are lost. **Important**: For I&M projects, consult the Project Lead, Data Manager, or GIS Specialist before creating a GPS Data Dictionary to verify what features and attributes are to be collected and that they will be compatible with project databases.

A. Pathfinder Office: Select *Data Dictionary Editor* under the *Utilities* menu. Name the new Data Dictionary file in the Name field.

i. Click *New Feature* button under the *Feature* pane. *New Feature* dialog box appears. Select point, line or area (polygon) under *Properties* tab and name the new feature. Click *OK*.
ii. Click *New Attribute* in the *Attributes* pane. Select *Attribute Type* and click *Add* (six attribute types are available; see *Help* for descriptions of each).
a. *New Attribute* dialog box appears. Name the attribute and specify values or options. For example, if collecting information on trees, such as species and DBH, create a **point** *feature* and create **species** and **DBH** *attributes*. The **species** attribute would be a *menu* attribute with different tree species being attribute *values* (bigleaf maple, Pacific yew, Douglas fir, etc). DBH could be a *numeric* attribute, where a number between 0 and 100 might be entered.
b. **Tip**: Use *menu* attributes whenever possible, since it is much faster in the field to select an attribute from a menu than to enter the attribute value by hand.

B. GeoXM/XT: It is not recommended to create a new Data Dictionary on the GPS unit due to the extra time needed to type in the Data Dictionary entries. However, if Pathfinder Office is not available, a Data Dictionary can be created or edited on the GPS unit by opening the ***Data* window:**
i. Select *File Manager* from dropdown menu just below upper left dropdown list, and select *Dictionaries* under *Choose File Type* dropdown list.
ii. Select *New dictionary* or *Edit dictionary* under the *Options* menu.

5. Collect and edit any background files necessary for the project. Background files might include existing shapefiles (roads, trails, buildings, etc.) or digital ortho quads (DOQs).
A. Note that the background shapefiles need to be converted to .imp file format before they can be transferred to the receiver unit. This can be done in Pathfinder Office using the *Import* function under the *Utilities* menu.
i. Select the input shapefile and specify output folder.
ii. In the *Choose an Import Setup* box, select 'Sample ESRI Shapefile Setup' in the dropdown box, then click the *New* button to create a new, NCCN-specific shapefile import setup based on the Sample ESRI Shapefile Setup template.
a. In the New Setup dialog box, enter 'NCCN Shapefile' for the Setup Name, then select the Copy of Existing Setup radio button (Sample ESRI Shapefile Setup is already entered in the adjacent box). Click OK.
b. In the ***Import Setup Properties* window**, select the *Coordinate System* tab. Click the Change button to edit the parameters to match those of the source shapefile. For most NCCN parks, this should be:
- UTM for System, 10 North for Zone, NAD 1983 (Conus) for Datum, Meters for both Coordinate Units and Altitude Units.
- For Geoid Model, select the 'Other' radio button, then select GEOID99 (Conus) from the dropdown list (or whichever 'GEOIDxx (Conus)' is the most current, where xx denotes the year, in the version of Pathfinder Office being used).

c. In the ***Import Setup Properties* window**, for the *Data*, *ESRI Shapefile*, and *Output* tabs, leave the settings at the defaults. If unsure whether settings have been changed from the defaults, simply click the Default button on each tab to restore.
d. This NCCN Shapefile Setup will then be saved and available for future shapefile imports to .imp format.

6. Transfer Data Dictionary and background files to the receiver.
A. In Pathfinder Office select *Data Transfer* under the *Utilities* menu. The ***Data Transfer* window** opens and after searching briefly, should indicate connection to GPS unit.

i. If it does not find the unit, make sure *GIS Datalogger on Windows CE* is selected in *Device* dropdown menu.
ii. Select the *Send* tab in the ***Data Transfer* window**.

B. Click the *Add* button and specify the type of file to transfer (either Data File or Data Dictionary). Navigate to the file on the computer, click on the file in the Open dialog box, and check that the file name appears in the File Name field. Click the Open button.
C. In the ***Data Transfer* window,** click *Transfer All*.

7. Make sure the GPS unit is fully charged.
   A. Check the level of charge under Start/Settings/Control Panel/Power or double-tapping the battery icon in the status bar at the bottom.
   B. **Important!** If the unit has been stored completely off (rather than in suspend mode), the Date/Time properties must be reset (it reverts to 6/01/1999). Specify these by tapping the Clock in the status bar at the bottom of the screen. This is critical for successful differential correction of field data as rover files with GPS Date/Time stamps of 6/01/1999 will not be differentially correctable.
   C. If a GeoXM/XT receiver will be used in the field for more than a day without the ability to recharge it each evening, an external battery pack will be essential to extend battery life. Some NCCN parks have external battery packs; check if one is available before going out in the field.

Field Data Collection

1. Specifying GPS settings: Open TerraSync on the GPS unit. The receiver will automatically activate the GPS connection when TerraSync is opened (if it does not, tap on the *GPS* button, 'F1,' on the upper right side of display window). **Tip**: Tap the *Question Mark* button at any time to get context-sensitive help.
   A. Select *Setup* from the upper left dropdown menu. Select the following settings in the ***Setup* window** (only those that are essential or required are indicated; it is recommended leaving the any others at their default settings). Note: when the ***Logging* Settings window** opens, the **Input Panel** (keyboard) also usually appears for entry of text if needed. Tap the 'X' to close it if not needed as it obscures settings fields (it can be reopened at any time by tapping the icon in the status bar at the bottom).
      i. Logging Settings
         a. Select Yes for *Logging Velocity Data.*
         b. Select Yes for *Log SuperCorrect Data.*
         c. Select 1 meter for *Antenna Height* (unless using an external antenna, which if at head height, may be closer to 2 meters).
         d. Select Off for *Time* and for *Distance* under the *Between Feature Logging* option.
      ii. GPS Settings
         a. Select PDOP for *DOP type* (this is the default).
         b. Set *Max PDOP* to 6.0 (this is the default).
            - If no positions can be collected with this *Max PDOP* setting, it can be increased to 8.0 but it is preferable to keep this setting as low as possible.
            - Increasing the *Max PDOP* setting to 8.0 results in 3-5 meters horizontal error at OLYM; similar error could be expected at other mountainous NCCN parks, especially MORA and NOCA.
         c. Set *Min SNR* to 4.0 (this is the default).
         d. If vertical precision is not essential and terrain makes connecting to satellites difficult, HDOP may be used instead of PDOP.

- Uncheck box next to Productivity/Precision Bar.
- Select HDOP as *DOP type*, and enter 4.0 for *Max HDOP* (this is the default).

iii. Coordinate System
   a. Set the *Coordinate System*, *Datum*, *Altitude Reference*, and *Altitude Units* to match those of any GIS background files. For most NCCN parks, these will be: UTM for System, 10 North for Zone, NAD 1983 (Conus) for Datum, Mean Sea Level (MSL) for Altitude Reference, and Meters for both Coordinate and Altitude Units. Leave other parameters at the defaults.
      - Geoid will default to DMW 10x10 (Global) which is OK, even though it does not match the geoid model specified in Pathfinder Office settings in Step 2D of Pre-field Preparation. This is due to file size limits of the GPS unit.
      - Note that these parameters are only for display purposes; GPS rover files will always store coordinates in Latitude/Longitude with the WGS84 datum.

iv. Units
   a. Set distance units to *Meters.*
   b. Set area units to *Square Meters.*

v. Do not specify Real Time or External Sensors settings unless using a Beacon-on-a-Belt or a laser rangefinder. WAAS data (for real time correction) may not be available in all NCCN parks due to the satellites' low position over the horizon.

B. Connect or disconnect to GPS under the *Options* menu.

2. Verifying satellite availability and configuration:
   A. If connected to GPS, the *Skyplot* option under the ***Status* window** will show all the satellites currently in the sky (clear boxes) and the satellites currently being tracked and available for recording positions (filled boxes).
   B. The *Skyplot* will also display the coordinates of the current position (in units specified in *Coordinate System* settings) and the current *PDOP* (*HDOP)* value.
   C. The GPS settings are displayed at the bottom.
   D. Please do not change the *PDOP (HDOP)* and *SNR* settings from the ones indicated above, except as noted.
3. Create a data file in which GPS positions will be stored:
   A. To create a new file, switch to ***Data* window** and select *New File* under the dropdown menu. Change the default filename by selecting it and typing a new name using the **Input Panel** (activate by tapping the keyboard icon if needed). For data management purposes, some NCCN parks use a prefix letter in the filename that identifies a particular GPS unit. Please do not change the prefix letter of the filename.
   B. Select the *Generic Data Dictionary* or the custom Data Dictionary, if one was created for the project. Tap *Create.*
   C. *Confirm Antenna Height* dialog box pops up – tap *OK* to confirm 1m setting, if appropriate.
   D. Select a feature type appropriate for the data to be collected by tapping on a point, line or area (polygon) type in the Choose Feature pane. For custom Data Dictionaries, a list of previously created features will appear in addition to generic point, line, and area features.
      i. At this point, the Logging Interval settings for each feature type should be specified under the *Options* menu.
         a. Logging interval of 1 second is recommended for points.
         b. Logging interval of 5 seconds is recommended for lines and polygons, unless connection to satellites is sporadic, in which case 1 second may be preferable.

c. Alternatively, for line or polygons, a logging interval based on *Distance* can be specified if appropriate for the project (example: a position along a line will be logged every 200 meters rather than every 5 seconds).

ii. With an appropriate feature type selected, select *Log later* under the *Options* menu. This allows control over when GPS positions start logging to the file. If it is not selected, the GeoXM/XT automatically starts to log them as soon as the *Create* button is tapped, which may result in undesirable positions being logged.

iii. Tap *Create*, then tap the *Pause/Log* button in the upper right corner (or select *Log* from the *Options* menu) to begin logging positions.

iv. Pause or resume logging as needed by tapping on the *Pause*/*Log* button in the upper right corner of the ***Data*** or ***Map*** **windows**.

v. **Note: a minimum of 60 positions is recommended for point features or vertices within features (see below),** but the more collected, the greater the accuracy**.** Fill out the attribute information (use the default 'Comment' field if using the *Generic Data Dictionary*) while the feature is open. Tap *OK* to close the feature. Other features can be collected within the same file by tapping *Create* again, or tap *Close* to save the file and start a new one.

E. Options for data feature types:

i. To collect GPS positions along a continuous line with different attributes for different portions of the line, the **Segment Line** option allows entry of different attributes for each segment of a single line feature.

a. While logging positions for a line and after entering appropriate attribute information (either into a custom Data Dictionary or into the 'Comment' field of the *Generic Data Dictionary*) for the current segment, select *Segment Line* under the *Options* menu. The receiver will start a new segment and a new Data Dictionary window will open into which attributes can be entered.

b. Continue until all segments are logged and attributed, then tap *OK* to close the feature.

ii. To improve the accuracy of a simple line or polygon feature, it may be feasible to collect only the major vertices within the line or polygon feature. Using the vertex logging option available for lines and polygons, lines between the vertices are created automatically. For example, to GPS a rectangular polygon, it may be more accurate to collect many positions at each corner of the rectangle which will then be automatically averaged into a point for each corner and connected with straight lines than to simply walk around the perimeter of the polygon while logging positions every 1 or 5 seconds.

a. To collect vertices for averaging, first select *Log Later* under the *Options* menu before creating a new line or polygon feature. This will ensure that no positions are logged until desired.

b. Move to the location where the averaged vertex should be, then select *New Vertex* under the *Options* menu in ***Data*** **window**. The receiver will start logging positions, which is indicated by a red pulsating symbol and increasing number of collected positions in upper right corner. A *Remain stationary* message will appear below the *Options* menu.

c. Once enough positions for this vertex have been collected (at least 60 is recommended), tap *OK*. Walk to the next corner or where the next vertex should be and select *New Vertex* under the *Options* menu.

d. Repeat until all corners are collected then tap *OK* to close the feature. Note: for polygon features, it is not necessary to walk to the starting point – the receiver will automatically snap the last and first vertices together when *OK* is tapped.

iii. Features can be nested within current features. For example: while using GPS to map a trail, suppose a rare plant is sighted which must be recorded as a point feature. To do this, close the line feature currently being collected, collect the point feature, then select *Continue* under the *Options* menu in the ***Data* window**. Select the appropriate line feature and continue logging positions from where the line was left off.

F. Manage rover files and Data Dictionaries by selecting *File Manager* in the ***Data* window**. Files can be edited, deleted, and exported from the *File Manager*.

4. The ***Map* window** allows tracking the current data collection, displaying one background file at a time (if desired), digitizing features, and navigating to predetermined targets.
   A. Zoom in and out or pan the view by selecting a tool from the tools dropdown list, just below the upper left corner.
   B. To load a background file, select *Background File* under the *Layers* menu and select the needed file.
   C. Turn the background display on or off from the *Layers* menu by checking or unchecking *Background*.
   D. *Log* and *Pause* buttons are also available in the ***Map* window**.
   E. Features can be digitized onscreen or by entering known X,Y coordinates. For either approach, open a new feature in the ***Data* window** with the *Log Later* option (GPS must be paused to digitize). Switch to ***Map* window** and select the *Digitize* option under the *Map Tools* dropdown menu.
      i. To digitize a feature onscreen, tap the screen in desired location. Close feature in the ***Data* window** when done.
      ii. To enter X,Y coordinates, select *Enter Coordinates* under the *Options* menu (make sure coordinates are in the same coordinate system and datum as the display settings). Close feature in the ***Data* window** when done.
5. To ***Navigation* window** provides a means to navigate to a known coordinate location or set of locations.
   A. To navigate to a single known coordinate location, a point feature with the desired coordinates must first be created. Use one of the digitizing options above (Step 4E) to create the point with the desired coordinates. Close point feature in the ***Data* window** (but not the file).
      i. In the ***Map* window,** choose the *Select* tool under the dropdown menu. If the point feature has not displayed in the ***Map* window**, select *Zoom Extents* from the *Options* menu.
         a. Select the feature just created and select *Set Nav Target* under the *Options* menu.
         b. The icon representing the digitized point will change to a box with two crossed flags.
      ii. Go to the ***Navigation* window**, which will show one arrow pointing to the digitized location (small triangle in the outer circle) and another arrow pointing in the actual direction of travel (the inner circle with long line through it).
         a. The goal is to superimpose the two arrows. Walk in the direction in which the two line up. When they are perfectly in line, the target arrow will turn black.
         b. The ***Navigation* window** will indicate the distance and bearing to the target and will indicate in what direction to turn as needed.
         c. Use the *Options* menu to specify Navigation Options:
            - *Close Up Range*: The 'Close-up' screen can be activated when positioned within a specified distance of the target by choosing the default value of 5 meters, or typing in a preferred distance. Or select *None* to prevent the Close-up screen from displaying.

- *Close Up Style*: Specify the style of the Close-up screen by selecting map- or GPS-centered.

B. To navigate to a set of more than about 10 locations, it is more efficient to create a data file containing all the points' coordinates on a desktop computer prior to going into the field, rather than manually creating each one on the GPS unit as in Step 4Eii.
   i. The set of coordinates will need to be in dbf (dBASE), ArcGIS shapefile, or MS Access MDB format (see the Data Manager or GIS Specialist for help if needed).
   ii. Use the Data Transfer utility of Pathfinder Office to 'Import' the data file to the GPS unit.
   iii. From the ***Data* window**, select *Existing File* from the upper left dropdown menu, select the data file from the list of available files, then tap *Open*.
      a. Note: **do not** tap *Begin* – this is reserved for updating a point's coordinates using the GPS, which is a different objective.
      b. Tap once on a point to select it (double-tapping will open a new window used to update the point's coordinates with GPS – tap *Cancel* to escape this window).
   iv. Switch to the ***Map* window,** the selected point will display with a box around it.
      a. From the *Options* menu, select *Set Nav Target* and proceed as in Step 5Aii.
      b. To select a different point, select *Clear Nav Target* from the *Options* menu, then either tap another point in the ***Map* window**, or select one from the ***Data* window** as described above.
   v. **Very important!** Be sure that the coordinate system and datum of the data file is the same as what will be specified on the GPS unit display before transferring to and opening on the GPS unit.

6. Other important notes for field data collection
   A. If data collection is paused for more than about 15 minutes, battery power can be preserved by putting the unit in suspend mode. This is done by briefly depressing the power button – the screen will go black. Press the button again to turn on and restore the unit exactly as it was, i.e. if TerraSync or any files were open, they will still be open. There may be a 30 second delay in reactivating the GPS receiver and reconnecting to the satellites.
   B. Occasionally, some of these units fail to come out of suspend mode. DO NOT PANIC.
      i. If this happens, perform a hard reset by holding down the power button for at least 15 seconds (refer to Trimble manual). There will first be a warning, and then the unit will appear to be rebooting – continue holding down the button until the screen is completely blank.
      ii. Then, depress the power button again briefly to restart the unit.
      iii. TerraSync must be restarted and the Date/Time reset because it reverts to 6/01/1999 whenever the unit is turned completely off (**very important!**).

Appendix 3. Instructions for Use of Trimble GeoXM and GeoXT GPS Units with Trimble Pathfinder Office and TerraSync Software: Post-processing Field Data

1. Download data from GeoXM/XT to desktop computer using Pathfinder Office.
    A. Connect GeoXM/XT support module to desktop computer.
        i. Use USB cable to connect support module to desktop computer.
        ii. If USB is not available, use serial clip directly on handheld.
        iii. Make sure handheld is in sleep mode, then place in support module (it will automatically turn on once connected).
    B. Microsoft ActiveSync on the desktop computer (should be version 3.7.1, build 3244, or newer) should automatically start. If it does not, start manually by double-clicking icon on desktop or through Start/Programs/ActiveSync.
        i. In *New Partnership* dialog box, select *No*. Unit will be set up as a 'guest' in the desktop computer.
        ii. Click *Next* button. Connection to desktop computer is now established.
    C. Start Pathfinder Office (select project or create new project if needed).
        i. **Very important!** Specify display coordinate system for all files in the project by selecting *Coordinate System* under the *Options* menu. For most NCCN parks, the following settings should be selected: UTM for System, 10 North for Zone, NAD 1983 (Conus) for Datum, Mean Sea Level (MSL) for Altitude Measured From, and Meters for both Coordinate and Altitude Units.
        ii. From *Utilities* menu, select *Data Transfer*. ***Data Transfer* window** opens and after searching, should indicate connection to handheld.
            a. If it does not find handheld, make sure *GIS Datalogger on Windows CE* is selected in *Device* dropdown menu.
            b. Window should default to the *Receive* tab for receiving files from handheld.
        iii. From *Add* dropdown menu, select *Data File*. The *Open* dialog box allows browsing to and selecting files on unit. Click *Open*.
        iv. Click *Transfer All* in ***Data Transfer* window**, then *Close* in *Transfer Completed* dialog box (or *More Details* to see error log file if files did not transfer) and finally *Close* in ***Data Transfer* window**.
2. Differential Correction of Field Data Using Pathfinder Office.
    A. From *Utilities* menu, select *Differential Correction*.
    B. Browse to and select uncorrected Rover Files (they will have an .SSF extension).
    C. For Base Files, click *Internet Search*.
    D. If Pathfinder Office has not been used for several months, it is recommended to download the most current list of base station providers from Trimble's website as follows:
        i. In the *Internet Search* dialog box, click *New*.
        ii. In the *New Provider* dialog box, select *Copy the most up-to-date list from Trimble's site, and select from it*, then click *OK*.
        iii. Click *Yes* in *Confirm Internet Setup* dialog box.
        iv. Select desired base station from *Select a Base Provider* list.
    E. If Pathfinder Office base station list has been recently updated, select desired base station from *Base Data Provider* dropdown list in the *Internet Search* dialog box, then click *OK*.
        i. If desired station does not appear on dropdown list, click *New* and choose *Select from the current list* from the *New Provider* dialog box, click *OK*.
        ii. Select desired base station and click *OK*.
    F. Click *Yes* in *Confirm Internet Setup* dialog box. Required files spanning time frame of field data collection will automatically download to the Pathfinder Office project's 'Base' folder.

G. In *Reference Position* dialog box, the Station Northing, Easting, and Height should automatically be read from base files and already filled in. If necessary, the coordinate system can be changed to match the units of the base station file. Click *OK*.
H. Verify that the corrected rover file will be written to the desired folder in the Output Folder box. Change by clicking the Browse button if needed.
I. Click *OK* in the *Differential Correction* dialog box to run the differential correction.
    i. Differentially corrected rover files will now have the .COR filename extension.
    ii. Log file can be viewed to troubleshoot errors, if needed. Sometimes not all positions will be corrected. While this may not be a problem, it is up to the user to determine if an adequate number of positions have been corrected (at least 60 for points). Using a different base station for post-processing can sometimes increase the number of positions corrected.

3. Exporting Differentially Corrected Field Data to GIS (shapefile format) in Pathfinder Office.
    A. From *Utilities* menu, select *Export* and browse to location of differentially corrected files in the *Input Files* part of *Export* dialog box.
    B. The *Output Folder* should default to the current Pathfinder Office project 'Export' folder.
    C. In the *Choose an Export Setup* part of *Export* dialog box, select 'Sample ESRI Shapefile Setup' in the dropdown box, then click the *New* button to create a new, NCCN-specific shapefile setup based on the Sample ESRI Shapefile Setup template.
        i. In the New Setup dialog box, enter 'NCCN Shapefile' for the Setup Name, then select Copy of Existing Setup (Sample ESRI Shapefile Setup is already entered in the adjacent box). Click OK.
        ii. In the ***Export Setup Properties* window**, select the *Position Filter* tab.
            a. Make sure that 'Include Non-GPS Positions' is **not** checked.
            b. Use default settings for all other parameters (GeoXM/XT units only collect 3D positions, so specifying 'Filter by GPS Position Info' is not necessary).
        iii. In the ***Export Setup Properties* window**, select the *Coordinate System* tab.
            a. Select the Use Export Coordinate System radio button, then click the Change button to edit the parameters. For most NCCN parks, these should be the following:
                - UTM for System, 10 North for Zone, NAD 1983 (Conus) for Datum, Meters for both Coordinate Units and Altitude Units.
                - For Geoid Model, select the 'Other' radio button, then select GEOID99 (Conus) from the dropdown list (or whichever 'GEOIDxx (Conus)' is the most current, where xx denotes the year, in the version of Pathfinder Office being used).
                    i. If elevation GPS data was collected, it may be advised to download the latest geoid model from the Trimble website at: http://www.trimble.com/geoid_ts.asp?Nav=Collection-22910. For NCCN, select either GEOID03 (Region 1) or GEOID03 (Conus).
                    ii. This geoid model will facilitate the greatest vertical accuracy when exporting the GPS data to GIS.
            b. Alternatively, if the current Pathfinder Office project display has been correctly specified, click the 'Use Current Display Coordinate System' radio button.
            c. **Note**: Pathfinder Office does not apply a transformation to convert the native GPS file datum of WGS84 to the GIS required datum of NAD83 during the export procedure. This can introduce up to 1 meter additional horizontal error. If this is not acceptable, use the export settings specified above except use WGS84 for the datum. The datum can then be converted to

NAD83 in GIS using the correct transformation (the GIS Specialist can do this, or assist as needed).

iv. In the ***Export Setup Properties*** **window**, select the *Data* tab.
   a. In the 'Type of Data to Export' part of window, make sure *Features – Positions and Attributes* radio button is selected and choose *Export All Features* in the dropdown box (this is the default setting).

v. In the ***Export Setup Properties*** **window**, select the *Attributes* tab. In the 'Generated Attributes' part of window, use the following settings:
   a. For 'All Feature Types' select PDOP (or HDOP if it was used instead of PDOP), Correction Status, Receiver Type, Date Recorded, Time Recorded, Feature Name, Data File Name, Total Positions, Filtered Positions, and Data Dictionary Name.
   b. For 'Point Features' select Height, Vertical Precision, Horizontal Precision, Standard Deviation and Position.
   c. For 'Line Features' select Length (2D), Average Vert. Precision, Average Horiz. Precision.
   d. For 'Area Features' select Area (2D), Perimeter (2D), Average Vert. Precision, Average Horiz. Precision.

vi. In the ***Export Setup Properties*** **window,** select the *Units* tab.
   a. If the current Pathfinder Office project display has been correctly specified, click the 'Use Current Display Units' radio button (default).
   b. If the current Pathfinder Office project display has not been correctly specified, click the 'Use Export Units' radio button, then click the Change button to edit as needed.

vii. In the ***Export Setup Properties*** **window's** *Output* and *ESRI Shapefile* tabs, keep settings at the defaults. If unsure whether settings have been changed from the defaults, simply click the Default button on both tabs to restore.

viii. This NCCN Shapefile Setup will then be saved and available for future GPS data exports to GIS.

D. Click *OK* to run the Export utility.

E. **Important!** The exported shapefiles will be automatically saved in the Pathfinder Office Project's 'Export' folder, named using the feature name from the Data Dictionary. If the generic Data Dictionary was used, this will be point_ge, line_gen, and area_gen for point, line, and polygon features, respectively. The user has no control over these names. Thus it is imperative that once exported, the shapefiles be renamed something meaningful and copied to a different directory to prevent being overwritten during the next GPS data export.

Appendix 4. Trimble GeoExplorer II Operating Instructions

Battery Options

There are two battery choices; four AA batteries or a camcorder battery.

- The AA battery pack slides into the back of the GPS receiver. They do not last as long as the camcorder battery (about 3 or 4 hours for AA batteries and about 7 or 8 for a camcorder battery). Press the small black tab to release the battery pack. Make sure batteries are correctly oriented. Firmly push the battery pack back onto the GPS unit.
- The camcorder battery pack requires a cable with a clip at the end. One end of the cable plugs into the outlet on the bottom left side of the battery pack. The camcorder battery attaches to the clip end of the cable. A green light next to the connection should be on if the camcorder battery is providing power to the receiver. The external battery pack also contains a lithium battery.

External Antenna

The receiver has an internal antenna above the display screen, but using the external antenna will increase the chances of tracking four satellites. The antenna can be attached to a pole so that the antenna can be raised higher.

The external antenna is attached to the back of the receiver with an antenna cable. Make sure the cable connection is tight on the antenna and on the back of the GPS unit. Wrap tape around the antenna connection to the receiver to make sure the antenna connection does not tear out.

Projection and Datum

GPS units receive coordinate data from satellites in latitude and longitude in the WGS-84 datum. NCCN GPS units are typically set up to display coordinate information in UTM zone 10, NAD83.

Configuration Settings

Accuracy settings are entered into the receiver in the Configuration menu (#6 in the Main Menu). To see or change these, turn on the GPS receiver (push the all black button) and push the Esc button until the Main Menu appears.

1. scroll to Configuration (#6)
2. push enter (the diamond key)
3. scroll to Rover Options (#1)
4. push enter
5. Use the scroll keys to move up and down the list of configuration options
6. To change a setting, highlight it with the cursor
7. push enter
8. use the up or down arrow buttons to increase or decrease the number
9. push enter to accept changes
10. push Esc twice to get back to the Main Menu

Typical settings for OLYM are (NOCA settings are typically SNR Mask = 4, PDOP Mask = 6):

- Elev. Mask = 15,
- SNR Mask = 6,
- PDOP Mask = 8
- Pos. Mode = 3D (meaning only 3D positions will be stored in data files)

NOTE: Do not change PDOP to a value above 8. Accuracy will be compromised with higher PDOP values.

NOTE: PDOP and Elev. Mask can be changed to 20 and 12, respectively, if data are being collected from fixed wing aircraft or helicopter.

Please contact GIS staff for a full review of configuration settings for each project and for assistance with configuring GPS receivers.

Receiver Operation and Data Collection

Power On and Off

1. push the all-black bottom button to turn on the receiver.
   The Main Menu will appear. If the unit turns on and is on another screen, push the Esc button until the Main Menu screen appears.
2. use the arrow buttons to scroll through the Main Menu
3. to turn off the receiver, hold down the power button and simultaneously push the enter button

Satellite Signal Reception

To see if the receiver is tracking satellites, from the Main Menu:

1. scroll to GPS Status (#3)
2. push enter (the diamond button)
3. scroll to Sat Tracking (#1)
4. push enter
   This window will show how many satellites the receiver is currently tracking. The number of satellites being tracked will show in the bottom left corner as figure-eight symbols. There will be one symbol for each satellite being tracked. There will be no symbols if there are no satellite signals being received by the GPS unit. The numbers above the symbols also show which satellites (identified by number) are being tracked. There will be an arrow next to each satellite the unit is receiving signals from.

Open a File

1. to get back to the Main Menu, push the Esc key in the upper left corner of the receiver twice
2. scroll to Data Capture (#1)
3. push enter
4. scroll to Open Rov. File (#1)
5. push enter
   This will open a file within which points will be collected. The file name is listed in the upper left corner of the screen. The file name begins with a letter and is followed by the month, day, hour, and a letter. The hour is in UTC time, not local time. Each file that is opened is automatically named. The first file opened during each hour has the letter A at the end. The next file opened will have the letter B, and so on through the alphabet. When a file is opened during the next hour, the file name will display the new hour and the letter A at the end.

   The number of points being collected in the file is displayed in the upper right corner. Points are usually collected at the rate of one per second. If the number remains at zero then there are not four satellites being tracked or accuracy requirements are not being met. If the number is going up, then at least four satellite signals are being received within the specified accuracy settings. Collect points for 3 to 4 minutes or until you get at least 60 positions. If the receiver loses one or

more signals, or the accuracy goes down, then the unit will cease collecting points. Try waiting until the receiver picks up the signals again and begins collecting more points.

NOTE: Try to get a minimum of 25 points if satellite signals are fading in and out. The more points collected in a file, the more accurate the position will be (this is because the points are later averaged).

NOTE: If collecting point features, do not move from your position once the receiver begins collecting points! Moving will alter the average and the accuracy.

NOTE: Keep the external antenna facing directly up. If using the internal antenna, keep the GPS receiver facing up, not down or sideways.

NOTE: Use one file per location. Do not use one file to record multiple locations.

Data Entry into a Data Dictionary

1. open a file
2. scroll to "Select Feature" in the data file menu
3. scroll to the feature for which data will be entered
4. push enter; the blinking line is now the cursor
5. use the scroll buttons to highlight the attribute for which data will be entered
6. push enter to select that attribute and move into its data entry screen
7. use the up/down scroll buttons to scroll through the alphabet, symbols, and numbers until you reach the character or number you want
8. then use the left/right scroll buttons to move the cursor to the next data entry space
9. push enter when data entry for an attribute is complete
10. continue steps 3-9 For additional attribute data entry
11. push Esc button to return to the file menu

NOTE: If you do not select a feature from the data dictionary, the file will store a maximum of only one point.

Close a File

1. to close the file, scroll to Close File (#3)
2. push enter
3. confirm by scrolling to yes
4. push enter

NOTE: ALWAYS CLOSE THE FILE! If the file is not closed and you move to a new location, there is a good chance points will be collected in the file along the way or once you reach your destination. This will significantly alter location accuracy.

5. record the file name (e.g. g050319c, site 3) on a data sheet

Open Another File

1. to begin a new file, scroll to Open Rov. File (this will then have file name: letter, month, day, hour, B unless the next file is opened in the next hour, in which case the letter will be A again)
2. push enter

The number of satellites being tracked by the receiver can still be viewed, even if a file is being recorded.

1. scroll to Main Menu (#4)

2. push enter
3. scroll to GPS Status (#3)
4. push enter
5. scroll to Sat. Tracking (#1)
6. push enter
7. to get back to the file in order to close it, push the Esc button until you are back to the Main Menu
8. scroll to Data Capture
9. push enter
   This will return to the file screen (not to the Data Capture screen like it does when there is no file open)
10. close the file when sufficient positions have been collected

Current Position Information
View your approximate position by pushing enter on Position (#2) in the Main Menu. This will show your approximate position if four satellites are being tracked and accuracy requirements are met; otherwise, the receiver shows the last place the receiver calculated a position (indicated by Old Position displayed at the top of the screen).

Navigation to a Target Location
1. prior to field work, the waypoint averaging should have been configured: "WPT Averaging" (#11) in the Configuration menu should have been set to "On" and "# of psns:" (number of positions) to 60.
2. use map, compass, and coordinates displayed on the Position screen (push Enter on #2 in the Main Menu) to navigate as close as you can to your target location
3. go back to the Main Menu
4. scroll to Navigation (#4)
5. push Enter
6. scroll to Waypoint Setup (#4)
7. push Enter
8. scroll to Add Here (#1)
9. push Enter
10. the GPS unit will calculate an average position based on the next 60 positions received from satellites
11. when averaging is complete, the screen will display the waypoint name and the averaged coordinates

Reminders

- Do not move once a file begins collecting points to map a point feature.
- Data collected in files needs to be differentially corrected in the GIS office in order to calculate a more accurate position. Uncorrected positions can be up to 100 meters off.
- These units are water resistant, not waterproof!
- Make sure the receiver always has battery power, even when the unit is not on. ***Data could be lost if the unit is without power***.
- Do not block the external antenna when trying to record a file. You may have to move around to try to get the most unobstructed view of the sky. Drainages or areas blocked by steep slopes can make collecting points difficult.
- Planning charts can be created to show when the greatest number of satellites are available in the area.
- Turning off the receiver will NOT close the job file. You must close the file manually.
- If batteries die during data file collection, replace the batteries, resume data collection in the file.
- Consider battery limitations BEFORE going into the field.
- Consider memory limitations BEFORE going into the field.

Appendix 5. Trimble GeoExplorer 3 Operating Instructions

Battery Options

The unit uses an internal battery. The internal battery should last 10-14 hours of continuous use and is rechargeable only via the unit's cradle and an electric outlet. Contact an NCCN GIS Office for directions about how to use external batteries to supplement/replace the internal power.

External Antenna

Each unit has an internal antenna, but can be used with an external antenna. This greatly improves satellite signal reception. The external antenna is attached to the upper left side of the unit.

Projection and Datum

GPS units receive coordinate data from satellites in latitude and longitude in the WGS-84 datum. NCCN GPS units are typically set up to display coordinate information in UTM zone 10, NAD83.

Configuration Settings

Accuracy settings are entered into the receiver in the Configuration menu. To see or change these,
1. push the SYS button until a screen listing "Configurations", "Data Dictionaries", "Feature Settings" appears
2. use the arrow keys to highlight "Configurations" and push ENTER
3. use the scroll keys to move up, down, and across the list of configuration options
4. push ENTER on the desired configuration topic
5. use the arrow keys to scroll through configuration settings
6. to change a setting, highlight it with the cursor and push ENTER
7. use the arrow buttons to change settings
8. push ENTER to accept changes
9. push CLOSE to close a screen

Typical settings for OLYM are Elev. Mask = 15, SNR Mask = 6, PDOP Mask = 8, and minimum satellites = 4 (these are all under the GPS screen in the Configurations menu). NOCA uses SNR Mask of 4 and PDOP Mask of 6. PDOP and Elev. Mask can be changed to 20 and 12, respectively, if data are being collected from fixed wing aircraft or helicopter.

Receiver Operation and Data Collection

Power On and Off
1. Turn on the unit using the power button (black button on the lower right side of the unit)
2. To turn off the unit, hold the power button down until the screen goes blank.

Receiver Screens
The triangular "arrow" buttons are for scrolling. The ENTER button works like the enter key on a computer. The Fn button works like a function button on a calculator (see the blue lettering underneath the other buttons). Pushing Fn and OPTION buttons will bring up the main menu. The main menu lists other menus that can also be found using the SYS, DATA, and NAV buttons.

Push the SYS button to scroll through the three SYS screens. One shows batter power and the amount of free memory. Push the SYS button again to get to settings and data dictionaries (these options should not

have to be used if the unit has been configured to project needs before leaving the office – contact NCCN GIS staff for configuration assistance).

Use the DATA button to get to data collection and review menus

Satellite Signal Reception
Upon turning on the receiver, the screen will show a skyplot. The number of satellites being tracked is shown in the upper right corner. For each satellite available in the sky, there will be a box, with a satellite number inside, inside the skyplot. A darkened box means signals are being receiving from that particular satellite. A gray box means the satellite is in view, but the signal is not being received. The satellite numbers are repeated on the left hand side of the screen.

Open a File
1. Push the DATA button
   The next available file name will be displayed to the right of "File:" at the bottom of the display screen. Use the default file names. File names begin with a letter and are followed by the month, day, hour, and a letter. The hour is in UTC time, not local time. Each file opened is automatically named. The first file opened during each hour has the letter A at the end. The next file opened will have the letter B, and so on through the alphabet. When a file is opened during the next hour, the file name will display the new hour and the letter A at the end.

2. Use the arrow keys to highlight "Create new file" and push ENTER (if the unit contains no data files, then "Create new file" is the only option shown).

3. Depending on the data dictionary being used, a feature will need to be selected
   a) Generic data dictionary
      i. select Point, Line, or Area under "New Feature" screen
      ii. push ENTER
   b) Custom data dictionary
      i. select feature name (e. g. Building or Campsite) under "New Feature"
      ii. push ENTER

   This will open a file in which points will be collected. The number of satellites being tracked will be displayed in the upper right corner. The number of points being collected in the file will be displayed in the lower right corner. Points are usually collected at the rate of one per second. Use the LOG button to pause data collection.

   If the number remains at zero then there are fewer than four satellites being tracked or accuracy requirements are not being met. If the number is going up, then at least four satellite signals are being received within the specified accuracy settings. Collect points for 3 to 4 minutes or until you get at least 60 positions. If the receiver loses one or more signals, or the accuracy goes down, then the unit will cease collecting points. Try waiting until the receiver picks up the signals again and begins collecting more points.

   NOTE: Try to get a minimum of 25 points if satellite signals are fading in and out. The more points collected in a file, the more accurate the position will be (this is because the points are later averaged).

   NOTE: If collecting point features, do not move from your position once the receiver begins collecting points! Moving will alter the average and the accuracy.

NOTE: Use one file per location per feature. Do not use one file to record multiple locations. Do not use one file to record multiple features unless this has been discussed with NCCN GIS staff (for data processing reasons).

NOTE: Keep the external antenna facing directly up. If using the internal antenna, keep the GPS receiver facing up, not down or sideways.

Data Entry into a Data Dictionary
If a data dictionary is being used,
1. scroll to the proper feature and then push ENTER
2. use the arrow keys to highlight the attribute(s) for which data will be entered
3. push the ENTER button and use the scrolling keys and enter button to enter the appropriate data
4. push the CLOSE button when attribute data entry is completed

Change From One Data Dictionary to Another
A default data dictionary can be set in the "Configurations", "Data dictionaries", and "Feature settings" screen (one of the SYS screens), but multiple data dictionaries can be loaded onto a GPS unit and selected from for different individual files. To change to a data dictionary that is not set as the default:
1. push DATA until the "Collect new data" screen appears
   The current data dictionary is displayed at the bottom of the screen to the right of "Dictionary:".
2. use the down arrow key to scroll down to "Dictionary:"
3. push ENTER
4. use the scroll keys to select the desired data dictionary
5. push ENTER

The selected data dictionary will remain selected until it is changed again.

Close a Feature and a File
When a sufficient number of points have been collected in the file (or you have decided to give up on data collection),
1. push the CLOSE button to close the feature (this closes the feature, not the file!)
2. confirm whether or not to close the feature and push ENTER
3. YOU MUST ALSO CLOSE THE FILE if you do not want to collect multiple features per file by pushing the CLOSE button again
4. confirm whether or not to close the rover file and push ENTER

Open Another File
Use the arrow keys to highlight "Create new file" and push ENTER.

Open a Previously Collected File
1. use the arrow keys to highlight "Open selected file"
   This shows the "update feature" mode if a data dictionary is being used
2. push ENTER on the feature to update
3. enter the appropriate information

Review Files
1. push the OPTION key to review files
2. highlight the "File info" option to scroll through files and review collection times, number of positions, etc. (listed at the bottom of the screen)
3. press CLOSE to return to "Create new file" or "Open selected file" screen

Entering Offsets into a GPS File
Sometimes it is impossible to acquire four satellite signals at a target location, but four signals can be acquired at a certain distance and bearing from the target location (e.g. mapping a nest tree is impossible from the base of the tree, but possible from a small clearing 16 meters to the north). In a case such as this, an offset can be entered into a GPS file and GPS software will calculate a position using the entered offset.

1. while the GPS file is open, push OPTION
2. push ENTER when the Offset screen appears
3. push ENTER on "Bearing"
4. use the left/right arrow keys to scroll among the data entry boxes and use the up/down arrow keys to enter a bearing FROM YOUR CURRENT LOCATION TO THE TARGET LOCATION
5. push ENTER when finished entering a bearing
6. scroll to the next line, "Horiz. distance"
7. push ENTER
8. use the left/right arrow keys to scroll among the data entry boxes and use the up/down arrow keys to enter a distance IN METERS FROM YOUR CURRENT LOCATION TO THE TARGET LOCATION
9. entering a "Vert. distance" is optional, but should be entered the same way as the "Horiz. distance"
10. push CLOSE when finished entering offset data

Current Position Information
View your approximate position by pushing the SYS button until the skyplot screen appears. This will show your approximate position if four satellites are being tracked and accuracy requirements are met; otherwise, the receiver shows the last place the receiver calculated a position.

Navigation to a Target Location
Real-time GPS set-ups and WAAS signals are not always an option for NCCN parks. Averaging GPS positions is a means of determining a relatively accurate position in the field. This is useful when field crews are attempting to navigate to a target location.

1. use map, compass, and current position displayed in the skyplot screen to navigate as close as you can to your target location
2. push the DATA button
3. open a new file
4. collect 1-3 minutes of data (try for a minimum of 60 positions)
5. close the file
6. scroll to line that reads "File:" (below the "Create new file" and "Open selected file" boxes)
7. push ENTER
8. scroll to the file name of the file that was just collected
9. push ENTER
10. the average coordinates will be displayed
11. push CLOSE
12. push ENTER to confirm closing the rover file

Background Maps
Background maps are useful reference for fieldwork. For example, a background map can show target points where field crews will place plots, roads, trails, and park boundaries.

GeoExplorer 3 GPS receivers can display vector data (points, lines, polygons) in a background map. A maximum of two attributes can be displayed for each vector feature in the background map. Shapefiles are imported in Pathfinder Office and saved as a Pathfinder Office import file (.imp). Import files are

transferred to the receiver. Contact NCCN GIS staff for background map creation, imports, and proper configuration settings.

To view a background map in the GPS receiver:

1. press the DATA button
2. scroll to "Open selected file"
3. the name of the background map should be displayed to the right of "File:"
4. push ENTER
5. push DATA until the map is visible
6. use the scroll buttons to move around on the background map
7. to identify a feature in the background map
    a) use the scroll buttons until the crosshairs are on top of the desired feature
    b) the crosshairs will display the two selected attribute items
    c) if needed, push a scroll button to move away from the feature and to another feature
    d) push CLOSE to close the attribute display and the crosshairs

    NOTE: There is not a way to label features in the background map. The crosshairs are the only means of identifying features.

8. use the OPTION button to bring up a menu that allows for navigating around the map
    a) To zoom in or out
        i. Push OPTION
        ii. Scroll to Zoom in or Zoom out
        iii. Push ENTER
        iv. Repeat ENTER until the desired scale is reached
    b) To pan automatically (this will move the screen as you traverse off the currently displayed background map area)
        i. Push OPTION
        ii. Scroll to Pan On/Off
        iii. Push ENTER
9. to close a background map
    a) Push the DATA button to get to the other file screens
    b) or push CLOSE to close the file
10. close the GPS file

<u>Reminders</u>

- Do not move once a file begins collecting points to map a point feature.
- Data collected in files needs to be corrected in the GIS office in order to calculate an accurate position. Uncorrected positions can be up to 100 meters off.
- Do not block the external antenna when trying to record a file. You may have to move around to try to get the most unobstructed view of the sky. Drainages or areas blocked by steep slopes can make collecting points difficult.
- These units are water resistant, not waterproof!
- Planning charts can be created to show when the greatest number of satellites are available in the area.
- Turning off the receiver will close the job file.
- If batteries die during data file collection, replace the batteries, open a new data file.
- Consider battery limitations BEFORE going into the field.
- Consider memory limitations BEFORE going into the field.

Appendix 6. GeoExplorer II and GeoExplorer 3 GPS Receiver Data Processing and Export

Contact NCCN GIS staff to help set-up GPS software projects for GPS data processing and the default settings in the software.

Pathfinder Office Project Set-up

Pathfinder Office is relatively good for processing batches of GPS files and storing them in select computer directories. In order to have GPS files go where they are supposed to on the computer, a project must be set-up via Pathfinder Office. Once a project and coordinate system is set-up, they will remain as defaults.

1. launch Pathfinder Office from the computer
    a) a Select Project window will automatically pop up with a default project name, or the project worked on previously, will display
    b) if this is the proper project, click OK
    c) if this is the first time Pathfinder has been used for a project, then the project needs to be set-up
        i. click on the New button
        ii. type a project name in the Project Name row; the project name should be the Project_code or GPSData
        iii. type or use the Browse buttons to fill in where the backup, export, and base files will be stored (e. g. N:\Project_code\GPSData\Backup, N:\Project_code\ GPSData\Export, N:\Project_code\ GPSData\Base)
        iv. click OK
2. set the coordinate system
    a) click on the Options menu
    b) click on Coordinate System
    c) under System: select UTM
    d) under Zone: select 10 North
    e) under Datum: select NAD 1983 (Conus)
    f) under Altitude measured from: select MSL
    g) under Coordinate units: select Meters
    h) under Altitude units: select Meters
    i) click OK
3. set the display units
    a) click on the Options menu
    b) click on Units
    c) set Distance: to meters
    d) set Offsets: to meters
    e) leave others as the default (North Reference = true, velocity and area to metric units)
    f) click OK
4. set the time
    a) click on the Options menu
    b) click on Time Zone
    c) set the time to Pacific Day USA (for daylight savings time) which is -7 hours from UTC or to Pacific Std USA (standard time) which is -8 hours from UTC
    d) click OK
5. set differential correction filters and smoothing
    a) click on the Utilities menu
    b) click on Differential Correction
    c) click the Settings button

d) click the Output tab
e) click in Corrected Only
f) click the Code Processing tab
g) under Rover Processing Technique, click With Velocity Filtering
h) under Base Processing Technique, click With Filtering and Smoothing
i) accept defaults for all other tabs
j) push OK
k) close the Differential Correction window by pushing Close

6. create a base station list
   a) click on the Utilities menu
   b) click on Differential Correction
   c) if there are no GPS files listed under the Rover Files/Selected Files then click on the Browse button and select a GPS file from a folder where you have GPS files stored (otherwise the Internet Search button will be greyed-out)
   d) click on Internet Search
      i. click on New
      ii. select "Copy the most up-to-date list from Trimble's Internet site, and select from it
      iii. click OK
      iv. click Yes if a "Confirm Internet Setup" window appears
      v. read through the list of base stations and highlight one to add to the pick-list
      vi. click OK
      vii. click OK in the "Provider Properties" window
      viii. repeat the process at any time to add more base stations to the pick-list

NOTE: recommended base stations:

EBLA: CORS Whidbey Island, COOP-CORS Mount Vernon
FOVA: Portland Statue University CBS, USFS PNW Region CBS, CORS Kelso, CORS Tillamook, CORS Fort Stevens
LEWI: Portland Statue University CBS, USFS PNW Region CBS, CORS Kelso, CORS Tillamook, CORS Fort Stevens
NOCA: COOP-CORS Mount Vernon, Cansel Vancouver, SOPAC Friday Harbor, Thurston County
OLYM: CORS Whidbey Island, CORS Seattle, SOPAC Blyn, SOPAC Albert Head
SAJH: SOPAC Friday Harbor, COOP-CORS Mount Vernon

NOTE: Some base stations have more consistent and smoother operations than others. If a base station fails to have the needed files, try another base station. Base stations also differ in the logging rate of base files, so when available, select a station with the fastest logging rate, ideally less than 30 seconds.

GPS Receiver Connection to a Computer

Attach GPS receiver to a computer via the appropriate data transfer cable.

- GeoExplorer II's have a cable that attaches to the back of the receiver at the circular connection point to the upper left of the battery pack. The other end of the cable is a serial connection.
- GeoExplorer 3 units arc connected to computers one of two ways:
  a) *Serial clip*
  There is a clip that attaches to the upper back of the receiver. A serial cable can then be attached to the clip and to a computer.

b) *Support module*
The GPS receiver is placed on the support module (cradle). A serial cable can be attached to the top of the support module and to a computer.

Data Transfer from GPS Receiver to a Computer

Launch Pathfinder Office from the computer. Select the proper project name if it is not already selected as the default.

1. connect the GPS unit to the computer (see above directions)
2. turn on the GPS unit
    a) if using a GeoExplorer II unit, select Data Transfer (#7) from the Main Menu and push Enter
    b) if using a GeoExplorer 3 unit, files can transfer to the computer from any receiver display screen
3. click on the Utilities menu
4. click on Data Transfer
5. Pathfinder Office will automatically list the files contained in the GPS receiver in the Receive tab window
6. click Add
7. select Data File
8. click Transfer All
9. click Close after all files have transferred from the GPS receiver to the computer
10. click Close to close the Data Transfer window
11. disconnect the GPS receiver

NOTE: Delete files from the GPS receiver after differential correction! Files are transferred to the project folder and each file has an .ssf extension. Raw GPS data files are also stored in the "Backup" folder.

Differential Correction

1. click Utilities menu
2. select Differential Correction
3. Pathfinder Office will automatically list all the files (.ssf files) just transferred from the GPS receiver
4. click Internet search
5. select a base station from the pick list created earlier
    a) use the drop-down list to select a base station
    b) click OK
    c) click Yes to if the "Confirm Internet Setup" window pops up
    d) a data transfer window will pop up
    e) click OK when the computer finishes transferring base files and the "Confirm Selected Base Files" window pops up
        This window shows if the uncorrected .ssf file is fully covered by base station data.
    f) click OK in the "Reference Position" window
        This window shows base station information. Click OK and the "Differential Correction" window will appear.
6. click OK in the "Differential Correction" window to begin the correction process
7. click Close or More Details to finish the correction process

NOTE: Differential correction also produces a log file (.txt) that can be referred to for further information and details about each file's correction. Clicking on More Details in step 7 will open the log file.

NOTE: Differential correction creates a new file, with a ".cor" extension, for each raw file (.ssf extension) and stores it along with .ssf files in the project folder.

NOTE: Contact NCCN GIS staff for help with files that do not correct, or that have a low correction percentage. Often, trying a different base station will solve the problem.

Data Export

1. click Utilities menu
2. select Export
3. Pathfinder Office will automatically list all the corrected (.cor) files transferred from the GPS receiver. Choose "Sample ArcView Shapefile Setup" as an export format from the pick-list under Choose an Export Setup (ArcInfo formats, Access (.mdb), dBase (.dbf), or ASCII (.asc) can also be chosen).
4. click on the Properties button to set or double check export options
5. click on the Data tab
6. select the Type of Data to Export
    a) if a data dictionary was used, select Features – Positions and Attributes
        i. select Export All Features
        ii. push OK
    b) if a data dictionary was not used, select Positions Only
        i. if point data were collected, select "One point per input file (mean position)"
        ii. if point data were collected, but will be treated as a line (e.g. flight line), select "One point per GPS position"
        iii. if line data were collected, select "One line per input file"
        iv. if area (polygon) data were collected, select "One area per input file"
7. click on the Position Filter tab
    a) select Minimum satellites: 3D (4 or more SVs) under Position Filter Criteria
    b) uncheck Uncorrected box under Include Positions That Are
8. click on the Attributes tab
    a) check the following under All Feature Types
        i. PDOP
        ii. HDOP
        iii. Correction Status
        iv. Receiver Type
        v. Date Recorded
        vi. Time Recorded
        vii. Feature Name
        viii. Data File Name
        ix. Total Positions
        x. Filtered Positions
        xi. Data Dictionary Name
    b) check the following under Point Features
        i. Height
        ii. Vertical Precision
        iii. Horizontal Precision

iv. Standard Deviation
v. Position

c) check all option for line or area features

9. click on the Coordinate System tab
10. select Use Export Coordinate System
    a) if the system listed is NOT UTM zone 10, NAD 1983,
        i. click on the Change button
        ii. set the projection parameters to UTM zone 10, NAD 1983
11. click OK to close the properties windows
12. click OK in the Export window to begin the export process
13. click Close to finish the export process or click More Details to view the export log (.txt) file
14. Files are given a default name and stored, along with a log file, in the Export folder of the project folder. In order to prevent overwriting export files during future exports, use ArcCatalog or Windows Explorer to rename the exported shapefile. Rename shapefiles in a sequential manner that will make sense to the way the project stores and uses data (e. g. during a 2006 aerial elk survey, the first flight shapefile might be renamed to "elkflt06001.shp", the second flight renamed to "elkflt06002.shp", etc.).

NOTE: Shapefile exports do not have a projection file (.prj) exported with them. It is a good idea to use ArcCatalog to define the shapefile projection to UTM zone 10, NAD 1983.

Delete Files from GPS Receiver

Delete GPS files from GPS receivers only after files have been transferred to computers and backed-up, and ideally, after differential corrections have been completed.

Delete Files from GeoExplorer II Receiver

There is not a way to delete all files at once; each file must be deleted individually.

1. select Data Capture from the Main Menu
2. push the enter button
3. scroll to Delete Files
4. push enter
5. use the scroll keys to select a file
6. push enter
7. confirm file deletion by scrolling to Yes and pushing enter
8. select the next file(s) for deletion and repeat steps 6-7

Delete Files from GeoExplorer 3 Receiver

1. push the OPTION key to delete files
2. highlight the "Delete file(s)" option and push ENTER
3. use the arrow keys to select a file to delete and push ENTER
4. to delete many files at one time,
    a) push OPTION again
    b) push ENTER for "Delete all files"
    c) push ENTER to confirm all file deletion
5. push CLOSE to return to "Create new file" or "Open selected file" screen

Appendix 7. Trimble Mission Planning Software

Mission planning charts are useful information to have for planning field work and for checking satellite availability while in the field. The charts display satellite information at different times of the day for specified general areas. The satellite availability chart is particularly useful.

Collect Almanac File

A recent almanac file will need to be transferred from the GPS unit to the computer. An almanac file is collected automatically by GPS receivers when the receiver is turned on and allowed to track satellites for 3-10 minutes. Alternatively, a current almanac can be downloaded from the Trimble website (http://www.trimble.com/gpsdataresources.html, click on Current Ephemeris Data). The file name will be 'current.ssf' and can be renamed 'almanac.ssf' if desired. Save it in the Almanacs folder of the Trimble program files (C:\Program Files\Common Files\Trimble\Almanacs).

Attach GPS to a Computer

Attach GPS receiver to a computer via the appropriate data transfer cable.

- GeoExplorer II's have a cable that attaches to the back of the receiver at the circular connection point to the upper left of the battery pack. The other end of the cable is a serial connection.
- GeoExplorer 3 units arc connected to computers one of two ways:
    a) *Serial clip*
    There is a clip that attaches to the upper back of the receiver. A serial cable can then be attached to the clip and to a computer.
    b) *Support module*
    The GPS receiver is placed on the support module (cradle). A serial cable can be attached to the top of the support module and to a computer.

Almanac File Transfer from GPS Receiver to a Computer

Launch Pathfinder Office from the computer. Select the proper project name if it is not already selected as the default.

1. connect the GPS unit to the computer (see above directions)
2. turn on the GPS unit
    a) if using a GeoExplorer II unit, select Data Transfer (#7) from the Main Menu and push Enter
    b) if using a GeoExplorer 3 unit, the file can be transferred to the computer from any receiver display screen
3. click on the Utilities menu
4. click on Data Transfer
5. Pathfinder Office will automatically list the files contained in the GPS receiver in the Receive tab window
6. click Add
7. select Almanac
8. click OK to accept the default storage folder and file name for almanac files (C:\Program Files\Common Files\Trimble\Almanacs\Almanac.ssf)
9. click Transfer All
10. click Close after the file has been transferred from the GPS receiver to the computer
11. click Close to close the Data Transfer window
12. disconnect the GPS receiver

Open Mission Planning Software

1. launch Pathfinder Office from the computer
2. click on the Utilities menu
3. select Quick Plan

Set Current Date and Position

1. double check the date displayed and change if necessary
2. click OK
3. click Keyboard (the World Map and Cities are too coarse) in the "Add New Point" window
4. enter a place name in the box to the right of "Name:", such as Port Angeles
5. click in the Latitude boxes and enter the approximate latitude
6. click in the Longitude boxes and enter the approximate longitude
7. click in the Position Quality box and select "Estimated Coordinates"
8. click OK to go back to the "Add New Point" box

View Graphs

1. click on the Graphs menu
2. select Number SVs and PDOP, or any other graph you wish to see
3. click on the Options menu to view graph inputs, such as elevation masks, or to change graph parameters

Print Graph(s)

1. click on the File menu
2. select Print Graph

Exit Quick Plan

Click on the File menu and Exit to exit Quick Plan and return to Pathfinder Office.

Appendix 8. Thales MobileMapper Operating Instructions

Contact NCCN GIS staff to have MobileMapper Office software installed and to have MobileMapper GPS receivers initialized. The User Manual (.pdf) found under the Help section of MobileMapper Office is a useful reference.

Battery Options

MobileMapper GPS receivers use two AA batteries. These will last approximately 8 hours with the backlight on and 14-16 hours with the backlight off.

External Antenna

MobileMapper GPS units have internal antenna at the top of the unit. External antennas are not necessary in the field, but can be used. External antennas are required for mapping from aircraft or road vehicle. With the unit facing you, the antenna jack is on the upper right side underneath a small black rubber flap.

Hold the unit vertically so that the antenna is oriented correctly.

Projection and Datum

GPS units receive coordinate data from satellites in latitude and longitude in the WGS-84 datum. NCCN GPS units are typically set up to display coordinate information in UTM zone 10, NAD83.

Configuration Settings

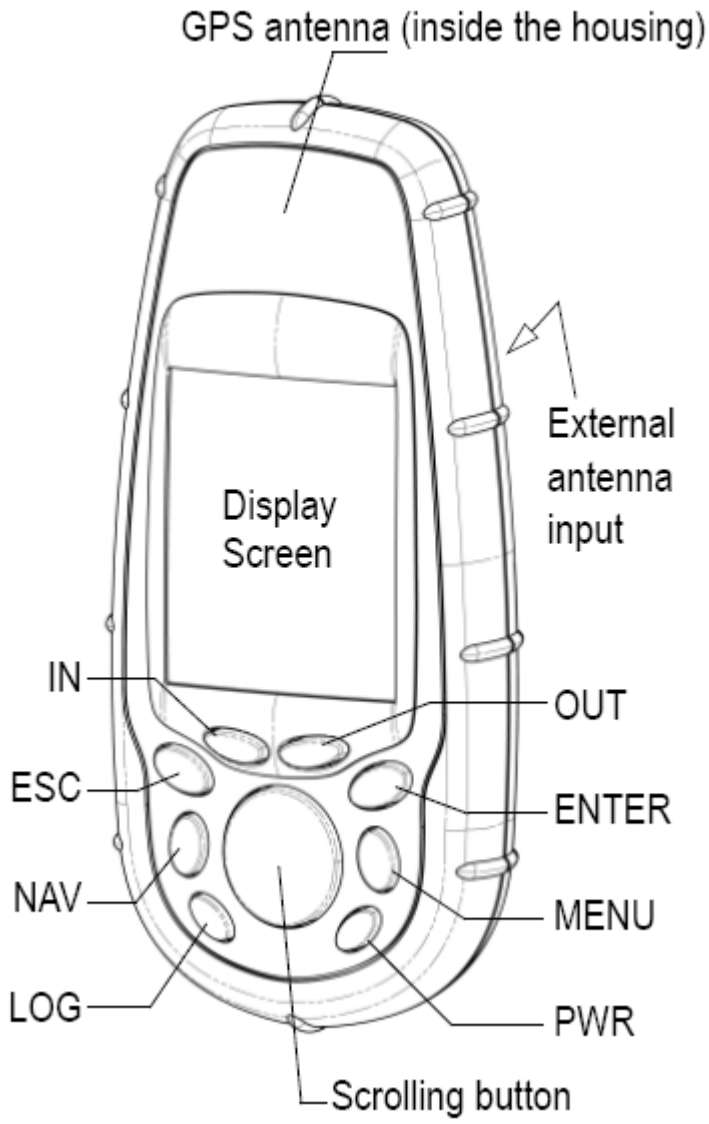
A major difference between Trimble GPS units and Thales units is the amount of control users have in configuration settings. Users cannot configure MobileMapper settings for PDOP, elevation masks, SNR ratio, logging interval rate, 2D or 3D reception.

Configuration settings in MobileMapper receivers consist of setting map display scales, selecting navigation screens, coordinate display, selecting background maps, and power options.

Receiver Operation and Data Collection

Power On and Off
Push PWR button to power on. Push ENTER when the disclaimer/warning screen appears or the unit will automatically shut off. To turn off the receiver, push PWR twice. Most NCCN MobileMapper units have been configured to prevent accidentally shut off by forcing users to push the PWR button twice.

Backlight
The backlight can be adjusted by using the PWR button. Push the PWR button for more than 2 seconds and then release it to change the backlight from high to low. Push the PWR button again for more than 2 seconds and then release it to change the backlight from low to off. Push the PWR button again for more than 2 seconds and then release it to turn the backlight on again.

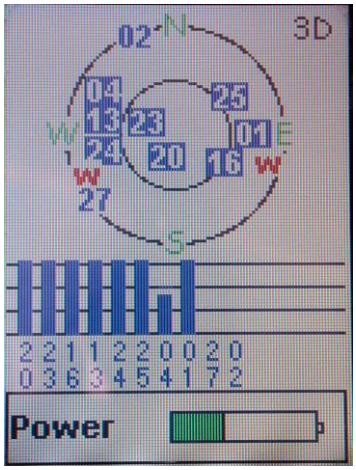


Receiver Screens

The NAV button scrolls through navigation screens. Many navigation screens have been turned off (such as the road view) during the configuration/intialization process. The screens that will be used most are the satellite chart, the background map, the position screen, and the heading and bearing screen.

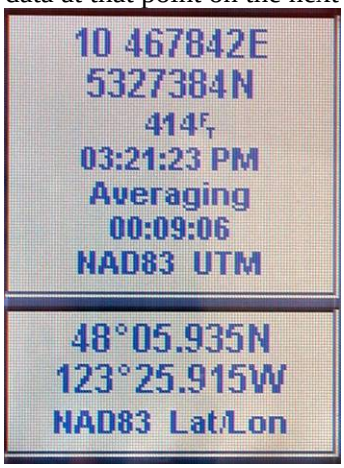
The ESC key steps back through previous screens.

Look for the Satellite Status screen. This shows the status of the battery power, how many satellites are being tracked (the solid bars in the graph) and whether the GPS is calculating positions in 2D or 3D mode (upper right corner). If there are 4 or more satellites being tracked and the 3D indicator appears then data recording can proceed.



Check Signal Reception and Current Location

Push the NAV button until the Position screen appears. This will also show the status of how strong satellite signals are. The line that reads "Averaging" will indicate, whether the GPS is "Search – 1st sat", "Search – 2nd sat" … or Averaging. Averaging will only show up if the GPS is getting a good signal and is stationary. If it is averaging, it will also show the duration at which the unit has been receiving satellite data at that point on the next line (e. g. 9 minutes and 6 seconds).



Open a File

When you are ready to collect a data file,

1. push the LOG button.
2. highlight Create New Job and push ENTER

3. use the scroll arrows to get to Clear (bottom of the keyboard)

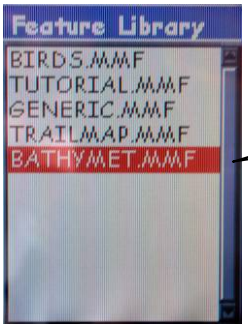
Change file name from "Job1" to, for example, "M060710"

4. push ENTER
5. use the scroll arrows and ENTER button to type in a job file name
   job files should be named the following standard way:
   Xyymmdd
   Where:
   X = GPS unit letter (see the back of the GPS unit; for example, MORA = M, NOCA = N, OLYM = O)
   Yy = last two digits of the year (05)
   Mm = month (use two digits!)
   Dd = day (use two digits!)
6. scroll to OK when finished typing in the job file name
7. push ENTER

   NOTE: There is an 8 character limit in file names.

After naming the job file,

8. select a feature library (called a data dictionary in Trimble's realm)
9. select XXXX.mmf where XXXX is the specific feature library



Select the data dictionary created for a specific project

10. push Enter and the Job Mode screen will appear

11. select Post-processing !

12. push ENTER

The New Feature screen will appear

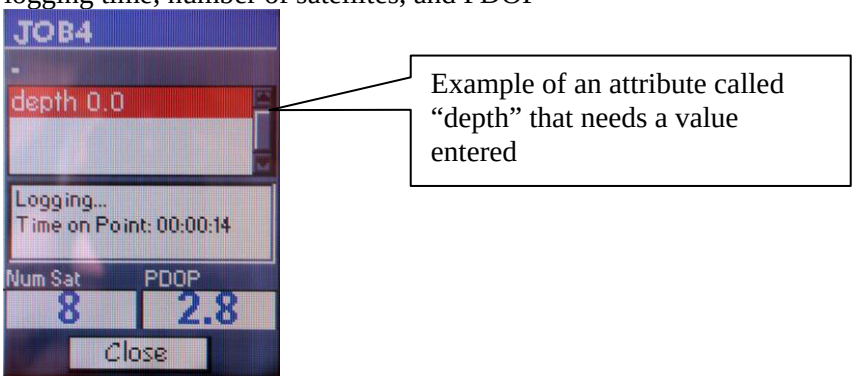
13. select the feature for which data will be collected
14. push ENTER

> **NOTE**: if the default data dictionary is being used, then the screen will display choices "Point, Line, Area, Grid".
>
> **NOTE**: Positions will not begin to collect in a file until the GPS unit begins receiving three or four satellite signals.
>
> **NOTE:** Hold the unit vertically so that the antenna is oriented correctly

Once the GPS unit receives sufficient satellite signals,

15. push ENTER

    The screen will change from showing feature type information (e. g. New Feature/XXXXPlot) to a screen for feature data collection that shows: data dictionary attributes that need data entry, logging time, number of satellites, and PDOP



NOTE: The MobileMapper does not show the number of points collected in a file like Trimble files do. Try to watch the elapsed time window and keep an eye on the PDOP. Try to collect at least 3 minutes of PDOP =<8.0 (make your best guess).

Data Entry using a Data Dictionary

If a data dictionary is being used,

1. scroll to the proper feature and then push ENTER
2. use the scroll keys and Enter button to type in attribute data
3. push ENTER when finished entering attribute data
4. select OK when finished

Close the Feature

1. scroll to CLOSE when finished logging the feature
2. push ENTER
   This returns to the New Feature screen.

   NOTE: This closes the feature, not the file.

3. write the GPS file name on a hardcopy datasheet

Open Another Feature in the Same File

When the feature is closed, the New Feature screen will appear. From here, a new feature (for example, map a new plot) can be opened.

1. scroll to the feature you wish to map
2. push ENTER
3. enter attribute data (see *Data Entry using a Data Dictionary)*
4. close the feature (see *Close the Feature)*
5. write the GPS file name on a hardcopy datasheet

Close a File

To close out of the entire job file,

1. push MENU
2. scroll to Close Job
3. push ENTER

Open File Again to Collect New Feature

1. To open a job file again,
2. push the LOG button
3. select Open Existing Job
4. push ENTER
5. select the job file name
6. push ENTER
7. push LOG to get to the New Feature/Plot screen and wait for satellite signals
8. push ENTER and log another plot location feature
9. write the GPS file name on a hardcopy datasheet

To close out of the entire job file,

1. push MENU
2. scroll to Close Job
3. push ENTER

NOTE: You can also re-open a job from pushing the MENU button and selecting Open Job.

NOTE: There is no set rule for how many jobs to create and how many features (plot locations) to log per job. Differential correction and export can be done on only one job at a time. Fewer jobs will facilitate data post-processing and GIS layer creation. Let's try doing one job file per day and see how that goes.

NOTE: Turning off the unit will close an open job file (unlike the Trimble units, the file will not stay open).

NOTE: If batteries die during a job file, replace batteries, open a new job file and begin data collection again.

Entering Offsets into a GPS File
From within the data file being collected,

1. press MENU
2. scroll to Offset
3. press ENTER
4. scroll to "Bearing"
5. press ENTER
6. obtain a compass bearing from your position to the target location
7. use the arrow keys to enter the bearing value
8. press ENTER when finished entering the bearing value
9. use the down arrow key to move to the "Horz. Distance" field
10. push ENTER
11. use the arrow keys to enter a horizontal distance (meters)
12. press ENTER when finished entering the horizontal distance value
13. use the down arrow key to move to the "Vert. Distance" field
14. push ENTER
15. use the arrow keys to enter a vertical distance (meters) (zero if current position and target position are on a flat plane)
16. press ENTER when finished entering the vertical distance value
17. press ESC to return to the data logging screen

NOTE: The map screen will show the feature offset from your current position.

Current Position Information
Use the position screen to see current coordinates and obtain a running average of your current position. It will show the duration and average UTM's during that duration. Relatively small movement (like

shoulder width distance) will reset the duration clock and create a new running coordinate average. This screen shows a primary (at the top) and secondary (at the bottom) coordinate system (these displays are set during the configuration process). NCCN units have UTM zone 10, NAD 1983 as the primary coordinate screen. The "10" preceding the easting at the top is the UTM zone.

Background Maps

Background maps are useful reference for fieldwork. For example, a background map can show target points where field crews will place plots, roads, trails, and park boundaries. Background maps will display at scales set during map creation in MobileMapper Office and at a level set in the GPS unit configuration.

Only one background map at a time can be transferred to the MobileMapper GPS unit via the MobileMapper Office software. The background map is automatically assigned the name "Detail00" during the transfer process. Multiple background maps can be loaded onto a GPS unit only by using a SD card reader. Contact GIS staff for assistance.

MobileMapper GPS receivers can display vector data (points, lines, polygons) in a background map. One attribute can be displayed for each vector feature in the background map. Shapefiles are imported in MobileMapper Office and saved as a map file (.mmp) Background maps are transferred to the receiver. Contact NCCN GIS staff for background map creation, imports, and proper configuration settings.

To view a background map in the GPS receiver, use the IN and OUT buttons to zoom in and out. Use the scroll arrows to move around the map and to set a center point for zooming in and out. A black triangle will show your present position (the triangle is really big and it is unclear if it can be made smaller). Zoom out beyond a certain scale will show a more general map. Zooming in to the scale set during map creation in MobileMapper Office will show more detail.

> **NOTE**: The black cursor on the background map will not zoom in beyond 10 meters on the display.

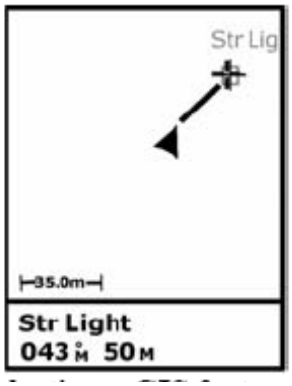
Navigation to a Target Location

Use map, compass, and the background map to navigate as close as possible to a target location. Switch to the Position screen, using the NAV button, to read current position coordinates and check them against the target coordinates. Use the position screen and a coordinate averaging to fine-tune your location.

The GOTO option in the receiver is useful to create a bearing and heading from a current position to a target location.

1. push the NAV button until the background map displays

2. if the GPS is receiving a minimum of 4 satellites, a black arrow cursor will display your current location
3. use the arrow scroll keys to move the center of the cross shaped selection cursor to the location to which you want to travel from your present location
4. when the cursor is over the feature, the feature's name will display at the bottom of the screen
5. press ENTER
6. this return to the Select Item screen
7. select the feature you want to go to
8. push ENTER
9. this will display the Detail Info screen
10. scroll to the GOTO option in the lower right corner
11. highlight GOTO
12. press ENTER
13. the background map will now show a line between your current position (the black triangle cursor) and the target location



14. press NAV until the navigation screen you wish to use displays)the screen that shows distance, bearing, and heading is a useful one)

NOTE: Setting the target location depends on the scale the background map is on when GOTO is selected. If the cursor appears to be on top of the target at a background map scale of 750 meters, the cursor location can be 20-30 meters away from the target when zoomed to a scale of 10 meters.

NOTE: Remember these screens will give straight line distances! It will not account for topography such as cliffs, rivers, etc. This GOTO option is probably best used after using map, compass, and altimeter to navigate close to a target point or polygon. Then use GOTO and the position display screen (where coordinate averages display) to refine your location and get as close as possible to the target location.

NOTE: The GOTO screen and background map will not zoom into a scale finer that 10m. At this point, use the position screen to make finer adjustments in navigation. The position screen will show a running average of a current position. It will show the duration and average UTM's during that duration. Relatively small movement (like shoulder width distance) will reset the duration clock and create a new running coordinate average.

Appendix 9. Thales MobileMapper GPS Receiver Data processing and Export

Contact NCCN GIS staff to help set-up GPS software projects for GPS data processing and the default settings in the software.

NOTE: Files collected on the GPS are termed "jobs" and files saved via MobileMapper Office are named "jobs" (both have .mmj extensions).

MobileMapper Office Project Set-up

1. open MobileMapper Office program from the computer and create a job file
    a) click on the File menu
    b) select New
    c) click on the File menu again
    d) select Save As
    e) navigate to a computer or network directory in which a PC job file will be stored
    f) name the file
    g) push Save
2. set the coordinate system
    a) click on the Options menu
    b) select Coordinate System
    c) click the drop-down arrow in the Spatial Reference System window
    d) select UTM/WGS84/UTM zone 10N
        i. if no coordinate system has been selected yet, click <new> from the drop-down list
        ii. select "SELECT a PRE-DEFINED system"
        iii. click the Next button
        iv. scroll down to UTM in the left pane of the Coordinate System Wizard – Select window and double click
        v. double click on WGS 84
        vi. select UTM/WGS 84/UTM zone 10N from the right pane in the Coordinate System Wizard – Select window
        vii. click on the Finish button
        viii. click on the browse button to the right of the drop-down list
        ix. click on the Datum tab
        x. select NAD83 from the Datum Name: pick-list
        xi. click OK
        xii. make sure the new option is selected in the Select Coordinate System window
    e) click OK

    NOTE: MobileMapper Office does not display the pick-list as NAD83; it displays as UTM/WGS 84/UTM zone 10N

3. set the units
    a) click on the Options menu
    b) select Units
    c) select m, km/hectare

Open this job file each time GPS job files are downloaded from the GPS unit to the PC desktop.

Data Transfer between GPS and MobileMapper Office

1. connect the GPS to the computer using the serial cable
2. turn on the GPS unit
3. launch MobileMapper Office if it is not already open
4. in MobileMapper Office, click on the File menu
5. select Download from GPS
6. click on the File menu within the MobileMapper Transfer window
7. select Connect
8. select GPS Device via Cable
   This will bring up a list of all the files in the GPS unit on the left side pane.
9. use the dropdown box in the right side pane to navigate to the directory to which GPS files will be copied and stored (e. g. "Raw" or "Unprocessed" folder)
10. copy files from the left pane to the right pane by
    a) highlighting the job(s) name (use Shift or Ctrl keys to highlight multiple files),
    b) right clicking,
    c) and selecting Copy to
    This will automatically begin the file(s) transfer from the GPS unit to the directory in the right pane.

    NOTE: Use the Copy option, not the Move option. It appears to be safer to copy, not move. The Move option takes the files out of the GPS unit and into the directory shown in the right pane. NCCN has experienced transfer errors that corrupt GPS receiver job files using the Move option.

    NOTE: Highlight and copy only the GPS receiver job files. There is no need to copy background map and feature library files.

11. close the data transfer window
    This will return to the main MobileMapper Office job window.

Differential Correction

Because differentially correctable GPS files were collected, the file transfer process actually transferred four files per job file, not one file. If the file list is viewed in MobileMapper Office's Transfer window, you will see each job file listed once. If the job files are viewed in Windows Explorer, there will be four files listed for each job file (this is analogous to GIS shapefiles and whether they are viewed via ArcCatalog or Windows Explorer). The GPS files have extensions: .b00, .d00, .e00, and .mmj. The "b", "d", and "e" files contain measurements used for differential correction. All four files are necessary to accomplish differential correction.

1. click the File menu from the main MobileMapper Office window
2. select Open
3. navigate to the folder in which GPS receiver job files (.mmj) have been stored
4. select one job file
5. click the Open button
   This will open the job file and display the features in the MobileMapper Office window and it will display the differential correction menu at the bottom of the screen. Each feature within the GPS receiver job file will be shown on one line in the differential correction window. The Time Bar will appear red.

NOTE: MobileMapper Office does not handle batch post-processing well. NCCN GIS staff has found it to be easiest to differentially correct one GPS receiver job file at a time.

NOTE: the differential correction window will not show up if the file was collected with the real-time option, not the post-processing option, in the GPS receiver.

6. click the Download Reference Station icon (the orange triangle with the yellow plus sign) to bring up the RINEX Download window
7. select NGS CORS to start with (or select another base station type if station codes are known)
8. select the base station you would like to use from the pick-list to the right of "Station:" or type in a station code (e. g. p432 for Mount Rainier National Park)

   NOTE: Click on the internet link in blue to the right of "Provider Infos:" to view CORS station information or find a station code.

   NOTE: Alternatively, click the Show CORS icon (the orange triangle with blue interior) to view CORS stations and their codes located near the job file location(s). You may need to zoom out quite a ways, using the zoom out button in MobileMapper Office's main window tool bar, to view this map.

   NOTE: recommended base stations:

   EBLA: CORS Whidbey Island, COOP-CORS Mount Vernon
   FOVA: Portland Statue University CBS, USFS PNW Region CBS, CORS Kelso, CORS Tillamook, CORS Fort Stevens
   LEWI: Portland Statue University CBS, USFS PNW Region CBS, CORS Kelso, CORS Tillamook, CORS Fort Stevens
   NOCA: COOP-CORS Mount Vernon, Cansel Vancouver, SOPAC Friday Harbor, Thurston County
   OLYM: CORS Whidbey Island, CORS Seattle, SOPAC Blyn, SOPAC Albert Head
   SAJH: SOPAC Friday Harbor, COOP-CORS Mount Vernon

9. check that the "Target Path:" specifies the project folder in which base files will be stored (such as "Base") or click the browse button to navigate to the proper folder
10. click the Download button
11. after all the necessary the base files transfer from the base station internet to the Base file folder, the transfer window at the bottom of the RINEX Download window will stop adding status lines
12. click Close
13. a merged base station file, comprised of all available base station files that spanned the same times of day that the GPS receiver file collected data, will list below the GPS receiver job file name
    The base station file will have an orange triangle icon next to its file name, will have a yellow Time Bar, and the GPS receiver job file will turn from red to green for the time overlap with the base station file.

    NOTE: Different base stations have different correction rates for each park and, to date, corrections have involved a lot of trial and error.

    NOTE: Some base stations have more consistent and smoother operations than others. If a base station fails to have needed files, try another base station.

14. click the Process data icon (the yellow triangle with a yellow gear-looking thing)

15. click OK when the correction status window pops up
16. go to MobileMapper Office's main window and click on the File menu
17. select Save As
18. navigate to the folder where processed GPS receiver files will be stored (e. g. "Processed")
19. name the GPS receiver job file with a "cor" suffix (e. g. file M060710.mmj is named M060710cor.mmj after differential correction) or with a "dnc" suffix

    NOTE: GPS receiver job files do not always correct 100%. Unlike Trimble's Pathfinder Office, MobileMapper Office does not report what percent of the job file did, or did not, correct and uncorrected positions cannot be filtered out during the export process. Files that do not correct 100% should not be given the "cor" suffix. Instead, save such files with a "dnc", for "did not correct" suffix.
20. click Save
21. to correct another GPS receiver job file, repeat this process

Delete Files from GPS Receiver

Delete GPS files from GPS receivers only after files have been transferred to computers and backed-up, and ideally, after differential corrections have been completed.

Delete Files from MobileMapper Receiver
With the GPS receiver turned on,
1. push MENU
2. scroll to Delete Files
3. push ENTER
4. scroll to the file to be deleted
5. push ENTER
6. scroll to Yes to confirm deletion
7. push ENTER

NOTE: Files must be deleted one at a time. There is no option for deleting all files at once from the receiver.

Delete Files from MobileMapper Receiver using MobileMapper Office
With MobileMapper Office open and the GPS receiver connected to the computer,
1. Click on the File menu
2. Select Download from GPS
3. click on the File menu within the MobileMapper Transfer window
4. select Connect
5. select GPS Device via Cable

   This will bring up a list of all the files in the GPS unit on the left side pane.
6. highlight the job(s) name (use Shift or Ctrl keys to highlight multiple files) that will be deleted
7. right click
8. select Delete

   This will delete the selected job files from the GPS receiver.

Appendix 10. Thales MobileMapper Mission Planning Software

Mission planning charts are useful information to have for planning field work and for checking satellite availability while in the field. The charts display satellite information at different times of the day for specified general areas. The satellite availability chart is particularly useful.

Open Mission Planning Software

The mission planning is a separate program that comes as part of MobileMapper Office.
1. go to the computer's Start button/Programs/MobileMapper Office
2. select Mission Planning

Almanac File

You will need to copy a recent almanac file from the GPS unit to the computer or you will need to copy an almanac file from the internet.
1. From the internet:
    a) go to Help/Get Almanacs
    b) click OK to go to the default website
    c) select the day for which an almanac file will be saved,
    d) right click,
    e) choose Save Target As
    f) navigate to C:/ProgramFiles/MobileMapperOffice/Pred/Raw
    g) save the file

2. From the GPS:
    a) click on the File menu
    b) select Download from GPS
    c) select Connect
    d) select GPS Device via Cable
    e) the GPS will list the most recent almanac file at the top of the file list
    f) navigate the right window pane to the default directory where MobileMapper Office stores almanac files, which is C:\ProgramFiles\MobileMapperOffice\Pred\Raw
    g) right click the almanac file in the left window pane
    h) select Copy to
    i) the software will copy the almanac from the GPS to the computer

3. Once the almanac file is saved to the computer,
    a) click on the File menu
    b) select Open
    c) select the almanac file you just copied to the computer (you may have to select "all files" to show and be able to select from all the almanac file types).

Create a Site

Next, select a site for the approximate location at which you want to know satellite availability.
1. click on the Edit menu
2. select Site
3. enter a Site name
4. enter the latitude and longitude coordinates of a location near the area of interest
5. the site can be saved in a file that gets a .pos extension

   a) click Save
   b) navigate to a selected folder to store the site data or accept the default folder (C:\Program Files\MobileMapper Office\Pred\Pos)
   c) name the position file
   d) click Save
6. click OK

Set Elevation Mask

Mission Planning seems to default to an elevation mask of 5 degrees.
1. click on the Options menu
2. select Elev Min
3. change the minimum elevation (yes, it decreases the available number of satellites!) to 15

View the Chart

In the View menu, select Schedule to get the number of available satellites at different times of the day.

The red line shows the number of satellites and the dark, thick horizontal bars represent different satellite numbers and when they should be available and for how long.

Use the View menu to change among different planning views.

NOTE: Double check the time zone.

NOTE: Feel free to play around with other options. These directions are just the basics!

Appendix 11. Thales MobileMapper Background Map Creation

MobileMapper GPS receivers can display vector data (points, lines, polygons) in a background map. One attribute can be displayed for each vector feature in the background map. Shapefiles are imported in MobileMapper Office and saved as a map file (.mmp). Background maps are transferred to the receiver. Contact NCCN GIS staff for background map creation, imports, and proper configuration settings.

Only one background map at a time can be transferred to the MobileMapper GPS unit via the MobileMapper Office software. The background map is automatically assigned the name "Detail00" during the transfer process. Multiple background maps can be loaded onto a GPS unit only by using a SD card reader. Contact GIS staff for assistance.

Start a MobileMapper Office Job File

1. open MobileMapper Office
2. click on the File menu
3. select New
4. click on the File menu
5. select Save As
6. navigate to a directory in which the MobileMapper Office job file (.mmj) (not the same as the MobileMapper receiver data file, also given an .mmj extension) will be stored on the computer
7. type a file name
8. click Save

Create a Background Map

1. click on the Tools menu
2. select Background Maps
   A window will open on the Vector Maps tab.
3. click on Map Editor
   This will bring up another window where shapefiles can be loaded.
4. leave the default scale at 1:100,000 (it is the minimum scale at which vector display; the scale can be changed later)
5. click on the Layer menu
6. select Add (or click the icon showing a yellow plus on a stack of papers)
7. navigate to the directory containing a desired shapefile
8. select a shapefile
9. click Open
   This adds the shapefile to the Vector Map Editor list. Add as many shapefiles as needed.

   NOTE: To remove a shapefile from the Vector Map Editor list, highlight the shapefile to be deleted, click the Remove layers icon (the red "x" on a stack of papers) or click on the Layer menu and select Remove.

10. set shapefile display parameters
    a) double click any of the cells in a row listing a shapefile
    b) change point symbols by clicking on the desired symbol
    c) change line types by clicking on the desired line in the Style drop-down list
    d) change line colors by clicking on the desired line color symbol
    e) change polygon fill patterns by clicking on Style drop-down list
    f) change polygon fill colors by clicking on the desired polygon color symbol

g) leave the scale at 1:100,000
h) click in the Display Attribute drop-down list
i) select the desired attribute from the shapefile for the MobileMapper GPS unit to display (e.g. “Name” for roads and trails or “Poly_num” for potential polygons target locations)

NOTE: Only one display attribute can be selected.

11. build the map
    The map is now defined and MobileMapper Office needs to compile it.
    a) click the Operations menu in the Vector Map Editor window
    b) click Create Map (or click the icon that looks like a yellow gear on top of a map)
12. save the compiled map
    a) click on the File menu
    b) select Save As
    c) navigate to a background map storage folder
    d) press Save (the file will be given an .mmp extension)
13. click the "x" in the upper right corner, or click the File menu and select Exit, to close the Vector Map Editor window
    This returns to the Background Maps window. This window will display all background maps that have been created for any MobileMapper Office project (.mmj) file.
14. associate the background map with the .mmj created at the beginning of this process
    a) click on the map name that was just created
    b) click the Attach Map button
       This will make the selected background map show for this .mmj file.
    c) click OK and the background map should display on screen (if it does not display, try zooming in to a larger scale)

Edit a Background Map

1. click on MobileMapper Office’s File menu
2. select Background Maps
3. click the Map Editor button
4. click on the Vector Map Editor window’s File menu
5. select Open Map Project
6. navigate to where the .mmp file is stored
7. select the .mmp file
8. click Open
9. follow above instructions for adding or deleting shapefiles, changing legend parameters, and changing display scales

Remove vs. Detach a Background Map

If the Remove button is clicked, the entire .mmp file is deleted from your computer; it's not just deleted from the current .mmj file! That’s okay if you want to delete a map. If you want to only detach a map, then click on the Detach Map button in the Background Maps window.

Transfer Background Map to GPS Receiver

1. connect the GPS unit up to the computer
2. click on MobileMapper Office’s File menu
3. select Upload to GPS

4. select Background Map
5. ignore the message saying a region has not been defined
6. click Yes
7. go through the upload wizard windows
8. accept the default selections for
    a) Upload to GPS Unit (click on Next),
    b) Target GPS Unit serial number (click on Next),
    c) Size and space screen (click Finish)
9. the GPS unit will show an Upload Active screen and the computer will show the progress of the upload
10. disconnect the GPS unit from the computer

View the Background Map in the GPS Receiver

1. turn on the GPS receiver
2. push the NAV button until the background map screen displays
3. use the IN and OUT buttons to zoom in and out
4. use the scroll buttons to move direction in the background map

    When viewing the GPS unit, different features should display at different scales. The unit has some preloaded general maps. Once zoomed in far enough the features loaded into your background map will display. You may have to zoom in to about 750m to 300m on the scale bar before background map features appear.

Change Background Map Scale

There are two ways to change background map scales:

- Adjust the scale in the MobileMapper Office background map program. Follow directions for "Editing Background Maps" and try different scales.
- Adjust the GPS unit background map display scale.

Adjust Background Map Display Scale in a GPS Receiver

1. follow above directions for creating and transferring background maps from MobileMapper Office to a GPS receiver
2. turn on the GPS unit
3. push MENU
4. scroll to Map Setup
5. on the Format tab, scroll to the Detail pick-list
6. push ENTER
7. scroll to select Highest, High, Medium, or Low
8. push ENTER
9. push ESC to return to the Setup Menu
10. push ESC or NAV to return to the background map screen

Select Among Different Background Maps in a GPS Receiver

11. follow above directions for creating and transferring background maps from MobileMapper Office to a GPS receiver
12. turn on the GPS unit
13. push MENU
14. scroll to Setup
15. push ENTER

16. scroll to Select Map
17. push ENTER

    This displays the Change Map screen and it shows Basemap as the Default Map and the Detail Map as something like Detail00, Detail01, Detail02. The Basemap is a MobileMapper default map. The Detail Map is a custom made background map.
18. scroll to Detail Map so that it highlights in red
19. push ENTER
20. a list of background maps appears along with the option for Detail Map Off

    NOTE: It does not appear that background maps can be named anything other than the default names of Detail00.img, etc. that MobileMapper assigns.

21. scroll to the map to be used as the background map
22. push ENTER
23. scroll to Save
24. push ENTER
25. push Esc to leave the Setup Menu
26. push NAV until the background map screen appears
27. use the IN and OUT buttons to zoom in or out until the selected background map appears

Appendix 12. Aerial GPS Data Collection Using Trimble GeoExplorer 3

Overview

The following directions describe two methods to collect flight path data. One option is to collect a generic point file for the duration of the flight. Another option is to use a background map to aid in navigation or data collection.

The GeoExplorer 3 should have firmware version 1.20 or later in order to best accomplish an aerial survey if a background map is being used. The 1.20 firmware provides better labeling options in the moving map screen under the "DATA" or "NAV" buttons.

Configuration files can be created using Pathfinder Office software, saved, and transferred to any GeoExplorer 3 GPS unit.

GPS Configuration

The following configuration settings are intentionally lax for accuracy settings in order to maximize data collection. The settings not mentioned are either up to the user to decide, or are okay at their default settings.

1. push the "SYS" button until the Configurations, Data Dictionaries, and Feature Settings screen appears
2. use the scroll keys to highlight Configurations
3. push Enter on Configurations
4. use the scroll keys to move around the Configurations screen
5. push Enter to open a Configuration screen option (Data, GPS, Real-time, Coordinate, Units, Formats, COMMS, Other)
6. once in a configuration screen option, scroll among settings
7. when a desired setting is highlighted, push Enter
8. change a setting using scroll keys
9. push Enter when finished changing a setting
10. push Close to return to the main Configurations screen

The following configurations should be set in the GeoExplorer 3 GPS unit.

Configuration / Data
Log between features = Off (if collecting a generic point file)
OR if using a background map,
Log between features = 1 second (1 second is good for relatively short flights such as 3-4 hours, 2 or 3 seconds for much longer flights such as 6-8 hours; time intervals also depend on available memory after loading a background map)
Log PPRT (to post process real time) = no
Log velocities = yes
Allow GPS update = no (if not updating feature attributes)
OR
Allow GPS update = yes (if updating feature attributes)

Configuration / GPS
PDOP = 20 (because time of points most critical, not accuracy)

SNR = 8
Elev. Mask = 12
Min. Sat. = 4

Configuration / Coordinates
UTM zone 10
NAD 1983 (conus)
Alt. Ref. = MSL
Coord. Units = meters
Alt. Units = feet

Configuration / Formats
Time = 24 hour
Time zone = -7.0 (daylight savings) or -8.0 (standard)
Coord. Order = east/north

Configuration / Units
Velocity = miles/hr
Distance = meters

For communication with laptop, need to set COMM configuration to:
Data transfer = support module
OR
Data Transfer = serial clip if data will be transferred between the GPS and computer using the serial cable instead of the support module cradle
RTCM = off
NMEA = serial clip
Baud input and output = 9600
Data bits = 8
Stop bits = 1
Parity = none

Creating a Background Map

If a background map is desired, Pathfinder Office software is needed to import shapefiles into the proper file format for the GPS unit and to create a data dictionary based on the items in the shapefile. If background layers exist as ArcInfo coverages, they must be converted to a shapefile (use the "arcshape" command in ArcInfo or using ArcCatalog). There is no option to load raster files as a background map. Only one background map will display in the GPS unit at one time. If multiple features are needed for reference, GIS layers can be combined prior to creating a GPS import file or multiple shapefiles can be selected during the import process.

> **NOTE**: Some coverages and shapefiles with polygon or line features have relatively large numbers of vertices that end up creating very large import files and use much of the available GPS unit memory. File size can be significantly reduced by using the ArcInfo command "generalize" before creating a GPS import file.

If it is not necessary to reference attributes in the background map on the GPS receiver, then the shapefile can be imported and a data dictionary will be automatically created along with the import process.
If background map attributes (e. g. Name, UnitNum) need to be referenced during flight, the import process needs to be done in two steps. The label feature in the GPS unit (version 1.20 or later) defaults to

using the first two attributes as labels. Shapefile tabular data structure needs to be modified so that the first two attributes are the desired attributes for use in the background map.

First, a data dictionary is created from the shapefile and attributes are deleted and rearranged so that attributes that will be displayed in the GPS units are the first two items listed in the shapefile's dBase file (.dbf). Second, the shapefile is imported and matched to the imported data dictionary.

1. launch Pathfinder Office (2.51, 2.70, or 2.90 have been used for these methods)
2. click on the Utilities menu
3. select Import
4. click on the Browse button
5. navigate to a shapefile's directory
6. select the shapefile,
7. click Open
8. click on the Change Settings button
9. click on the Data tab
10. make sure the GIS Format is set to Shapefile – ArcView
11. for the two-step import process to obtain needed attributes, select the radio button "Data Dictionary File Only"
    This first import process will create a data dictionary based on the shapefile's attributes.
12. go to the Coordinate System tab
13. set the coordinate system to match that of the shapefile
14. once all the settings have been selected,
15. click on OK get back to the main import menu
16. click on OK again to create the data dictionary
17. the data dictionary is named "imported.ddf"

The next step is to make modifications to the imported data dictionary so that the first two attributes are the attributes needed in the background map.

1. click on the Utilities menu
2. select Data Dictionary Editor
3. click on the File menu
4. open the data dictionary
5. use the data dictionary editor interface to delete any items that are extraneous to data collection or labeling during flights and to alter item order
   It is best to have the first two items be the data you wish to see as labels because the label feature in the GPS units with firmware version 1.20 or later defaults to using the first two attributes as labels. For example, a dictionary was created for an eagle nest location coverage by deleting default ArcInfo coverage or shapefile items (such as area, perimeter, internal identifier, and user identifier) and the "territory" and "nestnum" items were placed first and second in the attribute list. This was done by deleting other attributes or by highlighting each of the two items and going to the "Edit" menu and selecting "move up".
   a. to delete an item,
      i. highlight it
      ii. click on the Delete Attribute button
   b. to move an item up in order,
      i. highlight it with the cursor
      ii. click on the Edit menu
      iii. select Move up

6. once the data dictionary is finished being edited,
7. click on the File menu
8. select Save As or Save (rename the data dictionary to something more meaningful using Save As or leave it with its default name, import.ddf, using Save)

> **NOTE**: No matter what the data dictionary is named here, it will be called "generated by import" once it is transferred to the GPS unit and will need to be renamed in the unit. Close the Data Dictionary Editor.

Creating a Background Map (Import File)

To import the spatial data from a shapefile,
1. click on the Utilities menu
2. select Import
3. make sure the coordinate system listed matches the shapefile's coordinate system
4. select the radio button for Features with External Data Dictionary
5. click on the Data Dictionary File button
6. select the data dictionary that was just created
7. click on OK to get back to the main import menu
8. click on OK
9. the name of the imported shapefile is "imported.ssf"
10. launch Windows Explorer
11. navigate to the folder where the "imported.ssf" file was saved
12. right click on the file name
13. select Rename
14. give the file to a more meaningful name; the file will retain its name during the data transfer process to the GPS unit

Transfer a Background Map to a GPS Receiver

The data dictionary and the imported shapefile are now ready to be transferred to the GPS unit.

1. connect the GPS unit to the computer
2. launch Pathfinder Office
3. click on the Utilities menu
4. select Data Transfer
   Depending on the software version, the transfer menu interface will be slightly different.
5. select the type of file to transfer as Data Dictionary
6. click on the Send tab so files go from the computer to the GPS unit
7. select the Data Type as Data Dictionary
8. select the proper data dictionary
9. click on Transfer All
10. select the Data Type as Data
11. select the proper import file (.ssf)
12. click Transfer All
13. click Close to close the Data Transfer window

> **NOTE**: There was some trouble with a GeoExplorer 3 unit, with firmware version 1.20, receiving files from the computer using Pathfinder Office 2.70 and 2.51. A new data transfer program was downloaded from Trimble's website and used as a standalone utility to transfer the data dictionary and imported shapefile. The newer data transfer program created a problem with

opening 2.70 again. This was using Windows NT 4.0. Check Trimble websites for current patches if data transfer problems arise.

If attributes do not need to be referenced in a background map, then the shapefile import process can occur in one step. Instead of choosing "Features with External Data Dictionary", choose "Properties of Import File with Data Dictionary". This will create a data dictionary and shapefile import file at one time. Renaming and file transfer procedures are the same as above.

Rename the Import File within the GPS Receiver

1. turn on the GPS unit
2. push the SYS button until the Configurations, Data Dictionaries, and Feature Settings screen displays
3. highlight the Data Dictionary option
4. push ENTER
5. scroll to the data dictionary named "Generated by Import"
   This is the newly imported data dictionary.
6. rename this data dictionary by pushing the OPTION button
7. scroll to the Rename option
8. push ENTER
9. delete the current name
10. type a new name

Change Data Dictionary Feature Settings

Feature settings need to be checked and altered if the user wants to change data collection time intervals for newly created features.

1. push the "SYS" button until the Configurations, Data Dictionaries, and Feature Settings screen is displayed
2. scroll to Feature Settings
3. push ENTER
4. scroll to the proper data dictionary
5. push ENTER
6. scroll to the feature for which you want to confirm settings or modify
7. push ENTER

NOTE: The "interval" is probably best set to 1 or 2 (second(s)) to maximize the number of points collected for that feature (for something like animal location mapping), and flight time is not greater than 2.5 hours. Set the interval to 2 to 5 seconds if specific locations are not needed (via the time stamp for each GPS point), the goal is to map something only a flight path, and the unit will be running for extended time periods (>2-3 hours). The minimum number of positions should be set to 1 and the accuracy set to "code".

GPS Receiver Operation and Data Collection

Install the GPS antenna in the helicopter or airplane where it has the least obstructed view of the sky and is not in anyone's way. Duct tape works well for attaching the small GeoExplorer 3 antennas to helicopter dashboards. The antenna should not be placed under any metal fuselage parts of the helicopter.

Flight Line Data Collection without a Preloaded Background Map or Data Dictionary
If a generic file (i.e. e. no data dictionary) is to be used to map a flight line,

1. turn on the GPS
2. push the DATA button
3. highlight Create new file
4. push ENTER
5. select Point feature
6. push ENTER
   Points will begin being recorded as soon as satellite signals are received.
7. push the CLOSE button when finished
   This method will capture the flight line as a series of points.

Flight Line Data Collection with a Preloaded Background Map and Data Dictionary
If a background map is being used,

1. turn on the GPS unit
2. push the DATA button
3. highlight Open Selected File
4. select the imported shapefile
5. push ENTER
6. push the DATA button to scroll through the various data screens (update features, the map display screen, and adding a new feature screen) until the map display screen is shown
   This will bring up the preloaded background map. Points will begin being recorded as soon as satellite signals are received.
7. push the CLOSE button when finished
   This method will capture the flight line as a series of points.

Moving Around in the Background Map
To move around in the map screen,

1. push the OPTION button to bring up the background map option menu
   a) Zoom in
      i. push OPTION
      ii. scroll to zoom in
      iii. push ENTER
      iv. repeat as necessary to view the desired scale
   b) Zoom out
      i. push OPTION
      ii. scroll to zoom out
      iii. push ENTER
      iv. repeat as necessary to view the desired scale
   c) Pan
      i. push OPTION
      ii. scroll to Pan/select
      iii. push ENTER
      "Pan/select" means automatic panning is on. "Pan/select off" means it is turned off and the arrow buttons and crosshair will need to be used to move within the background map.
   d) Layers (these are GPS data collection layers, not different background map spatial layers)
      i. push OPTION
      ii. scroll to Layers
      iii. push ENTER
      iv. scroll to the various display options

v. push ENTER to turn on the layer
vi. push ENTER again to turn off the layer
vii. push CLOSE when finished

2. push the arrow buttons to put a crosshair cursor into the map screen and move the cursor around to different features
    a) when a feature is highlighted with the cursor, push the ENTER button to see a list of that features attributes.
    b) Push the CLOSE button when you are finished viewing that feature's attributes
    c) Push the CLOSE button to make the crosshair cursor disappear
    d) Push one of the arrow buttons to make the crosshairs appear again

> **NOTE**: The cursor must be over the top of a feature in order to see that feature's label(s) which are the one or two desired attributes selected during import file creation.

Depending on the nature of data collection, Olympic National Park staff has found it useful to open the selected file and go to the moving map screen, without opening a feature. Since the "log between features" configuration setting is set to a time (or distance) interval, points will be recorded in the file, but can be exported separately from the imported background map.

To map specific point locations along a flight path, a separate clock or watch (time in the "NAV" moving map screen can also be used) synchronized with the GPS time is used to record the time of an observation. These times are later used to create an observation spatial layer by either on-screen digitizing in GIS or by .dbf file attributing.

For example, there is not time to use a data dictionary to enter elk observation data into a GPS unit in the midst of the survey because it takes too much time looking at the GPS instead of counting or looking for elk. Elk group observation times (HH:MM:SS) were recorded onto hardcopy datasheets, along with other elk related data. After each flight, a shapefile or a coverage was created based on time and attributes recorded on datasheets matched to the exported GPS file with the attribute "gps_time" (see Pathfinder Office export attribute options).

Record Feature Data While a Background Map File is Open
A new feature needs to be entered to record feature data while a background map file is open. To enter a new feature,

1. push the DATA button
2. scroll to the New feature screen
3. push ENTER
4. collect the number of points necessary to most accurately map that feature.
5. push the CLOSE button

If time permits, highlight any of the feature attributes, push ENTER, and complete data entry for the feature being mapped. There is an option at the "New feature" screen to begin logging GPS points now or later, depending on what attributes you want to enter in advance of mapping the new feature. Features that have been already mapped can be updated using the "Update feature" screen. Take notes or use hardcopy datasheets if data entry into a GPS data dictionary will not happen while in the field.

> **NOTE**: Copying a feature's identifying number works fairly well. The one problem arises if there are no points collected in the GPS file for a feature and is therefore not exported during the data correction and export process. The feature identification numbers will then be off from your field notes. Use the CLOSE button to close the rover file.

NOTE: The moving map, along with time, date, and compass can be displayed in the NAV screens. Use the OPTION button to check what to display.

GPS waypoint creation for navigational use

Waypoint Text File Specifications
Waypoints can be imported into GeoExplorer 3 units to assist with navigation from the air. First, a text file with necessary attributes and x and y coordinates needs to be created. Pathfinder Office software requires that columns in the ASCII files be in a certain order with certain delimiters.

- ASCII files must be in the following order: x coordinate, y coordinate, elevation (or blank column in elevation is not being used), text fields.
- A blank column must be delimited by commas and the text column must have double quotes around the text. For example: 456000, 5310000, , "34".
- The file should be sorted in an order that is easy to search through on the GPS unit (e.g. sequentially on a unique number field or alphabetically based on a text field) before being saved to an ASCII file.
- If Excel was used for column and sorting manipulations, the file must be saved from Excel to an ASCII (.asc) file (MS-DOS format was not used, but I don't know if that matters).

Transfer Waypoint File from Computer to GPS Receiver
1. connect the GPS receiver to the computer
2. launch Pathfinder Office
3. click on the File menu
4. select Waypoints / ASCII Import
5. import the .asc file
6. name the new .wpt file
7. click on Utilities menu
8. select Data Transfer
9. click on the Send tab
10. click on the Add button
11. select Waypoints
12. navigate to where the waypoint (.wpt) file is stored on the computer
13. click the Transfer all button

View and/or Select Waypoints
In the GPS unit,
1. push the NAV button until the background map with a compass is shown (two other screens are a the background map screen and a road screen)
2. view the background map with selected associated information
    a) push the OPTION button
    b) scroll to Info windows
    c) push ENTER
    d) scroll to desired information options for display
        i. push ENTER to select up to three information display windows such as distance, bearing, heading, or time
        ii. push ENTER again to deselect information display windows
3. select specific target
    a) push OPTION
    b) scroll to Select target

c) push ENTER
d) scroll to desired waypoint name
e) push ENTER

4. push CLOSE to return to the NAV display screen

NOTE: If desired, push NAV until the background map displays to see the background map and the selected navigation information screens (time, distance, bearing). Move around this background map display the same way as under the DATA background map display by using the options listed when the OPTION button is pushed.